beans, infra-red heating of the cocoa beans, shell removal, screw pressing of nibs to extract the cocoa butter from the cocoa solids, milling the natural cocoa cake and/or alkalizing the natural cocoa cake and milling the alkalized cake. The method delivers both natural cocoa butter and powders (natural and/or value added alkalized powders) from the screw pressed nibs. The invention provides a method for processing cocoa beans to produce cocoa butter and cocoa powder that requires lower total assets since bean roasting and liquor milling are not required and a significantly less complex process with respect to maintenance, energy and labor.

One embodiment of the invention relates to a method of producing cocoa solids and cocoa butter comprising the steps of:

(a) heating cocoa beans having an outer cocoa shell and inner cocoa nib using infra-red radiation to an internal temperature greater than 115° C.;

(b) separating the shell from the nib; and

(c) subsequently extracting the cocoa butter by screw pressing the nibs.

One preferred embodiment comprises the steps of (a) air fluidized bed density separation to clean the cocoa beans, (b) infra-red heating of the cleaned cocoa beans at elevated temperatures exceeding 115° C., (c) shell removal, (d) screw pressing of the nibs to produce cocoa butter and cocoa cake, (e) alkalizing the cocoa cake, and (f) air-classified hammer milling of the natural and/or alkalized cocoa cake to produce cocoa powder.

A still further embodiment of the invention relates to a method of producing cocoa butter and cocoa cake solids comprising the steps of:

(a) cleaning a mixture comprising cocoa beans to separate cocoa beans from non-cocoa solids;

(b) heating cocoa beans having an outer cocoa shell and an inner cocoa nib using infra-red radiation to an internal temperature greater than 125° C.;

(c) removing the outer cocoa shell from the nib;

(d) screw pressing the nibs to extract the cocoa butter leaving cocoa cake solids; and

(e) cooling the cocoa butter to room temperature.

Preferably, the heating is to an IBT (internal bean temperature) greater than 120° C., advantageously greater than 125° C., even better greater than 130° C. and most preferred greater than 135° C. The heating preferably results in cocoa beans having a moisture content of about 3 percent by weight.

Another preferred embodiment of the invention relates to the use of infra-red heating of the cocoa beans at temperatures up to or exceeding 125° C. to result in a light roast and loosening of the shell and subsequently using a screw press to extract cocoa butter from the lightly roasted bean.

According to one embodiment, the surface temperature of the bean is heated from about 160 to about 170° C., while the internal temperature of the bean is preferably heated to about 130 to about 140° C. The resultant nibs should have a reduced moisture content of about 3% prior to pressing. The time of exposure to the infra-red heating is preferably about 0.5 to 4 minutes, however this may be varied depending on the amount of moisture in the nib. The bean height through the infra-red heater should be about two beans high.

According to another preferred embodiment of the invention, the infra-red heated beans are cooled to ambient temperature after the infra-red heating step. This is to avoid continued loss of moisture resulting from the infra-red heating prior to the screw pressing step. The nibs subjected to the screw press preferably have a moisture content of about 3% with a normal operating moisture range of between 2–6%.

The cocoa beans may be cooled to room temperature after the heating and subsequently pre-heated to a temperature between about 80° C. and about 90° C. prior to the step of screw pressing.

According to one preferred embodiment, prior to the step of heating, the beans are cleaned using a fluidized-bed separator. Preferably, the cocoa beans are subjected to a pre-cleaning step prior to cleaning in the air fluidized bed density separator.

Preferably, the step of separating includes a winnowing step to separate the shell from cocoa nibs prior to the pressing step.

Preferably, the screw pressing forms cocoa butter and cocoa cake solids. According to one embodiment, the cocoa cake solids are subsequently treated by alkalizing to form alkalized cocoa cake solids. The alkalized cocoa cake solids may be subsequently milled to produce fine cocoa powders.

Yet another embodiment of the invention relates to a method of winnowing cocoa beans comprising separating shells from an inner bean portion of the cocoa beans using an air fluidized-bed density separator. Preferably, the air fluidized-bed density separator comprises a means for homogenizing material introduced therein and at least one vibratory screen, advantageously the air fluidized-bed density separator comprises three vibratory screens. Surprisingly, greater than 99.5% of the shells are removed by the inventive method, preferably wherein less than 1.1% of the inner bean portion by weight are removed with the shell.

G. Novel Edible Products Containing Cocoa Polyphenols

Using the methods described above, novel edible compositions containing cocoa polyphenols, particularly enhanced levels of cocoa polyphenols, are made. The novel compositions are distinguishable from conventional compositions either because (1) the inventive compositions contain elevated levels of cocoa polyphenols relative to comparative conventional product (i.e., chocolates, chocolate-flavored confections, etc.) and/or (2) the inventive compositions contain cocoa polyphenols in contrast to the comparative composition which does not contain cocoa polyphenols (i.e., rice cakes, edible compositions without chocolate flavor/aroma, etc.).

1. Standard of Identity Chocolate one embodiment of the invention relates to a standard of identity chocolate comprising at least 3,600 μg cocoa polyphenol per gram chocolate, preferably at least 4,000 μg, advantageously at least 4,500 μg, even better at least 5,000 μg, and most preferred at least 5,500 μg cocoa polyphenols per gram chocolate. According to one preferred embodiment, the standard of identity chocolate contains least 6,000 μg cocoa polyphenols per gram chocolate, advantageously at least 6,500 μg, even better at least 7,000 μg, and most preferred at least 8,000 μg cocoa polyphenols per gram chocolate.

Another embodiment of the invention relates to a standard of identity chocolate comprising at least 200 μg cocoa polyphenol pentamer per gram chocolate, advantageously at least 225 μg, even better at least 275 μg, and most preferred at least 300 μg cocoa polyphenol pentamer per gram chocolate. According to one preferred embodiment, the standard of identity chocolate contains at least 325 μg cocoa polyphenol pentamer per gram chocolate, advantageously at least 350 μg, even better at least 400 μg, and most preferred at least 450 μg cocoa polyphenol pentamer per gram chocolate.

2. Standard of Identity Chocolate Containing Milk Solids

Yet another embodiment of the invention relates to a standard of identity chocolate containing milk solids and comprising at least 1,000 μg cocoa polyphenols per gram chocolate, advantageously at least 1,250 μg, even better at least 1,500 μg, and most preferred at least 2,000 μg cocoa polyphenols per gram chocolate. According to one preferred embodiment, the standard of identity chocolate contains at least 2,500 μg cocoa polyphenols per gram chocolate, advantageously at least 3,000 μg, even better at least 4,000 μg, and most preferred at least 5,000 μg cocoa polyphenols per gram chocolate.

Another embodiment of the invention relates to a standard of identity chocolate containing milk solids and comprising at least 85 μg cocoa polyphenol pentamer per gram chocolate, advantageously at least 90 μg, even better at least 100 μg, and most preferred at least 125 μg cocoa polyphenol pentamer per gram chocolate. According to one preferred embodiment, the standard of identity chocolate contains at least 150 μg cocoa polyphenol pentamer per gram chocolate, advantageously at least 175 μg, even better at least 200 μg, and most preferred at least 250 μg cocoa polyphenol pentamer per gram chocolate.

Preferably the standard of identity milk chocolate contains milk solids in an amount greater than or equal to 12% by weight.

3. Chocolates Comprising a Cocoa Component

Another embodiment of the invention relates to chocolates comprising a cocoa component, wherein the chocolate contains at least 3,600 μg, preferably at least 4,000 μg cocoa polyphenols per gram chocolate, advantageously at least 4,500 μg, even better at least 5,000 μg, and most preferred at least 5,500 μg cocoa polyphenols per gram chocolate. According to one preferred embodiment, the chocolate contains least 6,000 μg cocoa polyphenols per gram chocolate, advantageously at least 6,500 μg, even better at least 7,000 μg, and most preferred at least 8,000 μg cocoa polyphenols per gram chocolate.

Another embodiment of the invention relates to a chocolate comprising at least 200 μg cocoa polyphenol pentamer per gram chocolate, advantageously at least 225 μg, even better at least 275 μg, and most preferred at least 300 μg cocoa polyphenol pentamer per gram chocolate. According to one preferred embodiment, the chocolate contains at least 325 μg cocoa polyphenol pentamer per gram chocolate, advantageously at least 350 μg, even better at least 400 μg, and most preferred at least 450 μg cocoa polyphenol pentamer per gram chocolate.

4. Chocolates Comprising Milk Solids

Yet another embodiment of the invention relates to a chocolate containing milk solids (e.g., a milk chocolate) and comprising at least 1,000 μg cocoa polyphenols per gram chocolate, advantageously at least 1,250 μg, even better at least 1,500 μg, and most preferred at least 2,000 μg cocoa polyphenols per gram chocolate. According to one preferred embodiment, the chocolate contains at least 2,500 μg cocoa polyphenols per gram chocolate, advantageously at least 3,000 μg, even better at least 4,000 μg, and most preferred at least 5,000 μg cocoa polyphenols per gram chocolate.

Another embodiment of the invention relates to a chocolate containing milk solids and comprising at least 85 μg cocoa polyphenol pentamer per gram chocolate, advantageously at least 90 μg, even better at least 100 μg, and most preferred at least 125 μg cocoa polyphenol pentamer per gram chocolate. According to one preferred embodiment, the chocolate contains at least 150 μg cocoa polyphenol pentamer per gram chocolate, advantageously at least 175 μg, even better at least 200 μg, and most preferred at least 250 μg cocoa polyphenol pentamer per gram chocolate.

Preferably, the chocolate contains milk solids in an amount greater than or equal to 12% by weight.

5. Chocolates Comprising a Cocoa Component

Yet another embodiment of the invention relates to a chocolate comprising a fat phase and a cocoa component containing a cocoa polyphenols content from fair average quality cocoa beans, wherein the cocoa component contains at least 25% of the cocoa polyphenols content of the fair average quality cocoa beans, preferably at least 35%, advantageously at least 50%, even better at least 60% and most preferred at least 75% by weight.

A still further embodiment of the invention relates to a chocolate comprising a fat phase and a cocoa component containing a cocoa polyphenols pentamer content from fair average quality cocoa beans, wherein the cocoa component contains at least 15% of the cocoa polyphenols content of the fair average quality cocoa beans, preferably at least 20%, advantageously at least 25%, even better at least 35% and most preferred at least 50% by weight.

Yet another embodiment of the invention relates to a chocolate comprising a cocoa component and at least one fat, and further containing at least 7,300 μg cocoa polyphenols per gram cocoa component, preferably at least 8,000 μg, advantageously at least 9,000 μg, even better at least 10,000 μg, and most preferred at least 12,000 μg cocoa polyphenols per gram cocoa component.

Another embodiment of the invention relates to a chocolate comprising a cocoa component and at least one fat, and further containing at least 360 μg cocoa polyphenol pentamer per gram cocoa component, preferably at least 480 μg, advantageously at least 600 μg, even better at least 720 μg, and most preferred at least 800 μg cocoa polyphenol pentamer per gram cocoa component.

6. Chocolates Comprising Cocoa Solids

Another embodiment of the invention relates to a chocolate comprising partially defatted cocoa solids and at least one fat, and further containing at least 23,100 μg cocoa polyphenols per gram defatted cocoa solids, preferably at least 24,000 μg, advantageously at least 26,000 μg, even better at least 28,000 μg, and most preferred at least 30,000 μg cocoa polyphenols per gram defatted cocoa solids.

Another embodiment of the invention relates to a chocolate comprising partially defatted cocoa solids and at least one fat, and further containing at least 1,000 μg cocoa polyphenol pentamer per gram defatted cocoa solids, preferably at least 1,200 μg, advantageously at least 1,400 μg, even better at least 1,600 μg, and most preferred at least 1,800 μg cocoa polyphenol pentamer per gram defatted cocoa solids.

Another embodiment of the invention relates to a chocolate comprising partially defatted cocoa solids and at least one fat, and further containing at least 10,500 μg cocoa polyphenols per gram fat, advantageously at least 15,000 μg, even better at least 17,500 μg, and most preferred at least 20,000 μg cocoa polyphenols per gram fat.

Another embodiment of the invention relates to a chocolate comprising partially defatted cocoa solids and at least one fat, and further containing at least 520 μg cocoa polyphenol pentamer per gram fat, advantageously at least 750 μg, even better at least 900 μg, and most preferred at least 1,200 μg cocoa polyphenol pentamer per gram fat.

A still further embodiment of the invention relates to a chocolate comprising cocoa solids and at least one fat, and further containing at least 630 μg cocoa polyphenols per calorie, advantageously at least 750 μg, even better at least

900 μg, and most preferred at least 1,000 μg cocoa polyphenols per calorie.

Another embodiment of the invention relates to a chocolate comprising partially defatted cocoa solids and at least one fat, and further containing at least 32 μg cocoa polyphenol pentamer per calorie, preferably at least 50 μg, advantageously at least 60 μg, even better at least 72 μg, and most preferred at least 100 μg cocoa polyphenol pentamer per calorie.

A still further embodiment of the invention relates to a chocolate comprising partially defatted cocoa solids and at least one fat, and further containing at least 1,200,000 μg cocoa polyphenols per gram emulsifier, advantageously at least 1,500,000 μg, even better at least 1,800,000 μg, and most preferred at least 2,200,000 μg cocoa polyphenols per gram emulsifier.

Another embodiment of the invention relates to a chocolate comprising partially defatted cocoa solids and at least one fat, and further containing at least 58,000 μg cocoa polyphenol pentamer per gram emulsifier, advantageously at least 78,000 μg, even better at least 100,000 μg, and most preferred at least 120,000 μg cocoa polyphenol pentamer per gram emulsifier.

7. Chocolates Comprising Chocolate Liquor

A still further embodiment of the invention relates to a chocolate comprising chocolate liquor and at least one fat, and further containing at least 10,200 μg cocoa polyphenols per gram chocolate liquor, preferably at least 12,000 μg, advantageously at least 14,000 μg, even better at least 16,000 μg, and most preferred at least 18,000 μg cocoa polyphenols per gram chocolate liquor.

Another embodiment of the invention relates to a chocolate comprising chocolate liquor and at least one fat, and further containing at least 500 μg cocoa polyphenol pentamer per gram chocolate liquor, preferably at least 525 μg, advantageously at least 550 μg, even better at least 575 μg, and most preferred at least 600 μg cocoa polyphenol pentamer per gram chocolate liquor.

8. Additional Chocolates

A still further embodiment of the invention relates to a chocolate comprising at least one milk component and at least one fat, and further containing at least 8,400 μg cocoa polyphenols per gram milk component, advantageously at least 9,000 μg, even better at least 10,000 μg, and most preferred at least 12,000 μg cocoa polyphenols per gram milk component.

Another embodiment of the invention relates to a chocolate comprising at least one milk component and at least one fat, and further containing at least 465 μg cocoa polyphenol pentamer per gram milk component, preferably at least 1,000 μg, advantageously at least 2,000 μg, even better at least 3,000 μg, and most preferred at least 3,500 μg cocoa polyphenol pentamer per gram milk component.

A still further embodiment of the invention relates to a chocolate comprising at least one sugar and at least one fat, and further containing at least 7,100 μg cocoa polyphenols per gram sugar, preferably at least 10,000 μg, advantageously at least 13,000 μg, even better at least 16,000 μg, and most preferred at least 18,000 μg cocoa polyphenols per gram sugar.

Another embodiment of the invention relates to a chocolate comprising at least one sugar and at least one fat, and further containing at least 350 μg cocoa polyphenol pentamer per gram sugar, preferably at least 550 μg, advantageously at least 850 μg, even better at least 1,100 μg, and most preferred at least 1,350 μg cocoa polyphenol pentamer per gram sugar.

9. Chocolate-Flavored Confections

A still further aspect of the invention relates to chocolate-flavored confections (e.g., a chocolate-flavored hard candy) comprising a cocoa component, wherein the chocolate-flavored confection contains an effective amount of cocoa polyphenols per gram chocolate-flavored confection to provide a health benefit. Preferably, the chocolate-flavored confection (excluding chocolate) comprises at least 1 μg cocoa polyphenols per gram chocolate-flavored confection, advantageously at least 2 μg, even better at least 5 μg, and most preferred at least 10 μg cocoa polyphenols per gram chocolate-flavored confection. According to one preferred embodiment, the chocolate-flavored confection comprises at least 25 μg cocoa polyphenols per gram chocolate-flavored confection, advantageously at least 50 μg, even better at least 100 μg, and most preferred at least 150 μg cocoa polyphenols per gram chocolate-flavored confection.

The cocoa component may be selected from the group consisting of: (a) chocolate liquor; (b) partially defatted or fully defatted cocoa solids; (c) cocoa nib or fractions thereof; (d) cocoa polyphenol extract; and (e) mixtures thereof.

Another embodiment of the invention relates to chocolate-flavored confections comprising a cocoa component, wherein the chocolate-flavored confection contains an effective amount of cocoa polyphenol pentamer per gram chocolate-flavored confection to provide a health benefit. Preferably, the chocolate-flavored confection (excluding chocolate) comprises at least 1 μg cocoa polyphenol pentamer per gram chocolate-flavored confection, advantageously at least 2 μg, even better at least 5 μg, and most preferred at least 10 μg cocoa polyphenol pentamer per gram chocolate-flavored confection. According to one preferred embodiment, the chocolate-flavored confection comprises at least 25 μg cocoa polyphenol pentamer per gram chocolate-flavored confection, advantageously at least 50 μg, even better at least 100 μg, and most preferred at least 150 μg cocoa polyphenol pentamer per gram chocolate-flavored confection.

A still further aspect of the invention relates to chocolate-flavored confections (excluding chocolate) comprising a cocoa component, wherein the chocolate-flavored confection contains an effective amount of cocoa polyphenols per gram cocoa component to provide a health benefit. Preferably, the chocolate-flavored confection comprises at least 1 μg cocoa polyphenols per gram cocoa component, advantageously at least 2 μg, even better at least 5 μg, and most preferred at least 10 μg cocoa polyphenols per gram chocolate-flavored confection. According to one preferred embodiment, the chocolate-flavored confection comprises at least 25 μg cocoa polyphenols per gram cocoa component, advantageously at least 50 μg, even better at least 100 μg, and most preferred at least 150 μg cocoa polyphenols per gram cocoa component.

Another embodiment of the invention relates to chocolate-flavored confections (excluding chocolate) comprising a cocoa component, wherein the chocolate-flavored confection contains an effective amount of cocoa polyphenol pentamer per gram cocoa component to provide a health benefit. Preferably, the chocolate-flavored confection comprises at least 1 μg cocoa polyphenol pentamer per gram chocolate-flavored confection, advantageously at least 2 μg, even better at least 5 μg, and most preferred at least 10 μg cocoa polyphenol pentamer per gram cocoa component. According to one preferred embodiment, the chocolate-flavored confection comprises at least 25 μg cocoa polyphenol pentamer per gram cocoa component, advantageously at

least 50 μg, even better at least 100 μg, and most preferred at least 150 μg cocoa polyphenol pentamer per gram cocoa component.

10. Chocolate-Flavored Compositions

A still further aspect of the invention relates to a chocolate-flavored composition (excluding chocolate, e.g, a chocolate-flavored ice cream, etc.) comprising a cocoa component, wherein the chocolate-flavored composition contains an effective amount of cocoa polyphenols per gram chocolate-flavored composition to provide a health benefit. Preferably, the chocolate-flavored composition comprises at least 1 μg cocoa polyphenols per gram chocolate-flavored composition, advantageously at least 2 μg, even better at least 5 μg, and most preferred at least 10 μg cocoa polyphenols per gram chocolate-flavored composition. According to one preferred embodiment, the chocolate-flavored composition comprises at least 25 μg cocoa polyphenols per gram chocolate-flavored composition, advantageously at least 50 μg, even better at least 100 μg, and most preferred at least 150 μg cocoa polyphenols per gram chocolate-flavored composition.

Another embodiment of the invention relates to a chocolate-flavored composition comprising a cocoa component, wherein the chocolate-flavored composition contains an effective amount of cocoa polyphenol pentamer per gram chocolate-flavored composition to provide a health benefit. Preferably, the chocolate-flavored composition comprises at least 1 μg cocoa polyphenol pentamer per gram chocolate-flavored composition, advantageously at least 2 μg, even better at least 5 μg, and most preferred at least 10 μg cocoa polyphenol pentamer per gram chocolate-flavored composition. According to one preferred embodiment, the chocolate-flavored composition comprises at least 25 μg cocoa polyphenol pentamer per gram chocolate-flavored composition, advantageously at least 50 μg, even better at least 100 μg, and most preferred at least 150 μg cocoa polyphenol pentamer per gram chocolate-flavored composition.

A still further aspect of the invention relates to a chocolate-flavored composition comprising a cocoa component, wherein the chocolate-flavored composition contains an effective amount of cocoa polyphenols per gram cocoa component to provide a health benefit. Preferably, the chocolate-flavored composition comprises at least 1 μg cocoa polyphenols per gram cocoa component, advantageously at least 2 μg, even better at least 5 μg, and most preferred at least 10 μg cocoa polyphenols per gram chocolate-flavored composition. According to one preferred embodiment, the chocolate-flavored composition comprises at least 25 μg cocoa polyphenols per gram cocoa component, advantageously at least 50 μg, even better at least 100 μg, and most preferred at least 150 μg cocoa polyphenols per gram cocoa component.

Another embodiment of the invention relates to a chocolate-flavored composition comprising a cocoa component, wherein the chocolate-flavored composition contains an effective amount of cocoa polyphenol pentamer per gram cocoa component to provide a health benefit. Preferably, the chocolate-flavored composition comprises at least 1 μg cocoa polyphenol pentamer per gram chocolate-flavored composition, advantageously at least 2 μg, even better at least 5 μg, and most preferred at least 10 μg cocoa polyphenol pentamer per gram cocoa component. According to one preferred embodiment, the chocolate-flavored composition comprises at least 25 μg cocoa polyphenol pentamer per gram cocoa component, advantageously at least 50 μg, even better at least 100 μg, and most preferred at least 150 μg cocoa polyphenol pentamer per gram cocoa component.

11. Additional Products

Another aspect of the invention relates to an edible or ingestible or chewable product containing a cocoa polyphenols additive or a derivative thereof. According to one embodiment, the cocoa polyphenol additive is an extract from cocoa beans or a cocoa component thereof or the cocoa polyphenol additive is a synthetic compound structurally similar or identical to the cocoa polyphenols. Preferably, the product comprises at least 1 μg cocoa polyphenols per gram product, advantageously at least 2 μg, even better at least 5 μg, and most preferred at least 10 μg cocoa polyphenols per gram product. According to one preferred embodiment, the product comprises at least 25 μg cocoa polyphenols per gram product, advantageously at least 50 μg, even better at least 100 μg, and most preferred at least 150 μg cocoa polyphenols per gram product.

According to another embodiment, the product comprises at least 1 μg cocoa polyphenol pentamer per gram product, advantageously at least 2 μg, even better at least 5 μg, and most preferred at least 10 μg cocoa polyphenol pentamer per gram product. According to one preferred embodiment, the product comprises at least 25 μg cocoa polyphenol pentamer per gram cocoa component, advantageously at least 50 μg, even better at least 100 μg, and most preferred at least 150 μg cocoa polyphenol pentamer per gram product.

Accordingly, one embodiment of the invention relates to an ingestible product containing the cocoa polyphenols additive or a derivative thereof and a second ingestible component.

Another embodiment of the invention relates to a chewable composition (e.g., chewing gum) comprising a cocoa polyphenol additive or a derivative thereof.

Another embodiment of the invention relates to an edible composition comprising a cocoa component containing a cocoa polyphenols content from fair average quality cocoa beans, wherein the cocoa component contains at least 25% of the cocoa polyphenols content of the fair average quality cocoa beans, advantageously at least 35%, even better at least 50% and most preferred at least 65% by weight.

A still further object of the invention relates to an edible composition comprising a cocoa component containing a cocoa polyphenols content from raw freshly harvested cocoa beans, wherein the cocoa component contains at least 5% of the cocoa polyphenols content of the raw freshly harvested cocoa beans, preferably at least 10%, advantageously at least 15%, even better at least 20% and most preferred at least 25% by weight.

Yet another embodiment of the invention relates to an edible product comprising an edible composition and at least 1 μg cocoa polyphenols, wherein the edible product is substantially free of chocolate flavor and chocolate aroma (i.e., a rice cake coated with cocoa polyphenol extract). Preferably, the product comprises at least 2 μg cocoa polyphenols per gram product, advantageously at least 5 μg, even better at least 10 μg, and most preferred at least 20 μg cocoa polyphenols per gram product. According to one preferred embodiment, the product comprises at least 50 μg cocoa polyphenols per gram cocoa component, advantageously at least 100 μg, even better at least 150 μg, and most preferred at least 200 μg cocoa polyphenols per gram product.

According to another embodiment, the product free of chocolate aroma/flavor comprises at least 2 μg cocoa polyphenol pentamer per gram product, advantageously at least 5 μg, even better at least 10 μg, and most preferred at least 20 μg cocoa polyphenol pentamer per gram product. According to one preferred embodiment, the product com-

prises at least 50 μg cocoa polyphenol pentamer per gram cocoa component, advantageously at least 100 μg, even better at least 150 μg, and most preferred at least 200 μg cocoa polyphenol pentamer per gram product.

A still further object of the invention relates to an edible composition comprising a nonalkalized chocolate liquor substantially derived from cocoa beans having a fermentation factor less than 375, preferably, advantageously less than 350, even better less than 325, and most preferred less than 300. According to a preferred embodiment, the fermentation factor is less than 275, preferably less than 250, advantageously less than 225, even better less than 200, and most preferred less than 175. According to a particularly preferred embodiment, the fermentation factor is less than 150, advantageously less than 125, and most preferred about 100.

H . Methods of Using

Using the cocoa components and the products containing cocoa polyphenols described above, novel methods of improving the health of a mammal, particularly a human, may be practiced. The products of the invention can be used in any of the uses discussed in copending U.S. application Ser. No. 08/831,245, filed Apr. 2, 1997.

Another embodiment of the invention relates to a method of improving the health of a mammal by administering an effective amount of cocoa polyphenols to the mammal each day for an effective period of time. Advantageously, the effective period of time is greater than sixty days. In one aspect, the mammal's health is improved by ingesting an edible composition containing cocoa polyphenols each day for a period of time greater than sixty days. Preferably, the edible composition contains at least 1 μg of cocoa polyphenols, advantageously at least 5 μg, even better at least 10 μg, more preferred at least 25 μg, and most preferred at least 50 μg. In another aspect, the mammal's health is improved by ingesting a chocolate containing cocoa polyphenols each day for a period of time greater than sixty days. Preferably, the chocolate contains at least 1 μg of-cocoa polyphenols, advantageously at least 5 μg, even better at least 10 μg, more preferred at least 25 μg, and most preferred at least 50 μg.

One embodiment of the invention relates to a method of improving the health of a mammal by administering an effective amount of cocoa polyphenol pentamer to the mammal each day for an effective period of time. Advantageously, the effective period of time is greater than sixty days. In one aspect, the mammal's health is improved by ingesting a non-chocolate edible composition containing cocoa polyphenol pentamer each day for a period of time greater than sixty days. Preferably, the edible composition contains at least 1 μg of cocoa polyphenol pentamer, advantageously at least 5 Ag, even better at least 10 μg, more preferred at least 25 μg, and most preferred at least 50 μg. In another aspect, the mammal's health is improved by ingesting a chocolate containing cocoa polyphenol pentamer each day for a period of time greater than sixty days. Preferably, the chocolate contains at least 1 μg of cocoa polyphenol pentamer, advantageously at least 5 μg, even better at least 10 μg, more preferred at least 25 μg, and most preferred at least 50 μg.

The cocoa polyphenols or cocoa polyphenol pentamer has an activity selected from the group consisting of reducing periodontal disease, antigingivitis, antiperiodontis, reducing atherosclerosis, LDL oxidation inhibitor, reducing hypertension, antineoplastic, antioxidant, DNA topoisomerase II enzyme inhibitor, cyclo-oxygenase modulator, lipoxygenase modulator, NO or NO-synthase modulator, non-steroidal anti-inflammatory, apoptosis modulator, platelet aggregation modulator, blood or in vivo glucose modulator, antimicrobial and inhibitor of oxidative DNA damage activity.

In yet another embodiment of the invention, a physiological response is elicited in a mammal by administering an effective amount of cocoa polyphenols or cocoa polyphenol pentamer to the mammal.

The elicited response is sustained for a period of time, or the elicited response provides a benefit to the mammal in need thereof, advantageously to modulate the effects of an internal or external stress factor.

The elicited responses include lowering the oxidative stress index (such as increasing in vivo oxidative defense indices or decreasing in vivo oxidative stress), anti-viral response, anti-bacterial response, lowering cytokine level, increasing T-cell production level, lowering hypertension and dilating blood vessels, and the stress factors include oxidative stress, viral stress, bacterial stress, elevated level of cytokine, diminished level of T-cell production, hypertension and constricted blood vessels.

The compounds of the invention or compositions containing the compounds of the invention have utility for reducing periodontal disease, antigingivitis, antiperiodontis, reducing atherosclerosis, LDL oxidation inhibitor, reducing hypertension, anti-cancer, anti-tumor or antineoplastic, antioxidant, DNA topoisomerase II enzyme inhibitor, inhibit oxidative damage to DNA, antimicrobial, cyclooxygenase and/or lipoxygenase modulator, NO or NO-synthase modulator, apoptosis, platelet aggregation and blood or in vivo glucose modulating and nonsteroidal anti-inflammatory activities.

In addition to the physiological activities elicited by the compounds of the invention or compositions containing the compounds, other compounds present in cocoa or compositions containing other compounds from noncocoa, natural sources can be combined to produce a synergistic effect to the naturally occurring cocoa polyphenols, in particular cocoa procyanidins.

One embodiment of a synergistic effect on NO and/or NO synthase modulation, for example, follows. Many foods contain appreciable amounts of L-arginine, but not necessarily the compounds of the invention. Given that L-arginine is a substrate for NO synthase, and NO dependent vasodilation is significantly improved in hypercholesterolemic animals receiving L-arginine supplementation (Cooke et al., Circulation 83, 1057–1062, 1991), and the compounds of the invention can modulate NO levels, a synergistic improvement in endothelium dependent vasodilation is expected. L-arginine levels of 1.0 to 1.1 g/100 g have been reported in unsweetened cocoa powder. From this basis, other natural products rich in L-arginine, such as peanuts, would be incorporated into recipes for maximal benefit related to NO and NO synthase modulation.

Another embodiment relates to the use of a noncocoa source containing procyanidins. Cinnamon, for example, has been analytically examined for procyanidins and related compounds (Moritomo et al., Chem. Pharm. Bull. 33:10, 4338–4345, 1985; Moritomo et al., Chem. Pharm. Bull. 33:10, 2281–2286, 1985; Moritomo et al., Chem. Pharm. Bull. 34:2, 633–642, 1986; and Moritomo et al., Chem. Pharm. Bull. 34:2, 643–649, 1986), some of which are structurally related to the cocoa procyanidins. Moreover, cinnamon has been reported (Coe, S. D. and Coe, M. D., *The True History of Chocolate*, Thames and Hudson Ltd., London, 1996) to be a part of chocolate drink recipes since 1692. Thus, the inclusion of cinnamon (containing procyanidins) to cocoa (containing procyanidins) to prepare any cocoa snack, SOI or non SOI chocolate, beverage or edible food stuff would be expected to elicit a synergistic

physiological effect. Similarly, the addition of various citrus essential oils, would be expected to produce a synergistic effect with the indigenous cocoa procyanidins. Naturally expressed citrus essential oils contain numerous bioflavonoids and complex terpenoids, some of which have physiological properties such as geraniol (Burke et al., Lipids 32:2, 151–156, 1997). It is noteworthy that distilled citrus oils lack the bioflavonoids and that folded oils would contain different proportions of the terpene hydrocarbons, including the sesquiterpenes and their oxygenated forms, all of which can be manipulated to synergize with the numerous physiological utilities of the cocoa procyanidins.

The skilled artisan will recognize many variations from these examples to cover a wide range of formulas, ingredients (e.g. wine or tea solids), processing and mixtures to rationally take advantage of the synergistic effects of naturally occurring levels and distribution of cocoa procyanidins used in combination with other natural products containing identical or different phytochemicals. Further, the skilled artisan will recognize the inclusion of noncocoa phytochemicals in various combinations can be added as recipe ingredients to prepare SOI or non SOI chocolate, any cocoa based snack, beverage, syrup, cocoa, flavoring or supplement.

EXAMPLES

The following examples are illustrative of some of the products and methods of making the same falling within the scope of the present invention. They are, of course, not to be considered in any way limitative of the invention. Numerous changes and modification can be made with respect to the invention.

That is, the skilled artisan will recognize many variations in these examples to cover a wide range of formulas, ingredients, processing, and mixtures to rationally adjust the naturally occurring levels of the compounds of the invention for a variety of chocolate applications.

TABLE 1A

COCOA Polyphenols CONTENT OF FINISHED PRODUCTS IN EXAMPLES (micrograms/gram)

SAMPLE	THEORETICAL PENTAMER	ACTUAL PENTAMER	THEORETICAL POLYPHENOL	ACTUAL POLYPHENOL
Chocolate Cookie Control	181	37	2,482	1,978
Cookie 50:50	278	39	3,973	2,698
Cookie 100% Cocoa Polyphenols	376	46	5,464	3,841
Choco Power Bar	NA	trace	NA	100
VO2 control	NA	trace	NA	209
VO2 cocoa polyphenol	175	22	2,548	1,710
Cacoa Puffs	NA	trace	NA	27
Cereal	286	23	4,157	3,453
Fruit Bar	408	105	5,153	5,851
Fruit Bar Fitting	1,488	349	18,758	12,771
Jello-choco pudding	NA	trace	NA	trace
Pudding (stove)	352	70	18,758	1,559
Pudding (microwave)	352	67	18,758	1,406
Pudding (skim)	352	42	18,758	1,215
Mole control	1.5	trace	44	79
Mole 50:50	14.4	trace	188	155
Mole 100% cocoa polyphenol	27.4	trace	332	213
Quaker Choc puff rice	NA	trace	NA	trace
Sprayed rice cake	251.5	38	3,655	4,842
Brownie (control)	9.9	12	295	645
Brownie (50:50)	96.9	70	1,252	2,099
Brownie (100% cocoa polyphenol)	183.9	97	2,225	2,981
Chocolate-Flavored Nougat	2.4	18	34.2	776
Cinnamon Caramel	43	27	621	1,037

NA: Not Available

TABLE 1B

COCOA POLYPHENOL INGREDIENTS USED IN EXAMPLES

Cocoa Polyphenols MEDIUM	PENTAMER	TOTAL POLYPHENOL
Extract	29,767 μg	375,170 μg
Cocoa Powder	2,138 μg	31,072 μg
Liquor	1,957 μg	23,673 μg

EXAMPLE 1

Cocoa Source and Method of Preparation

Several *Theobroma cacao* genotypes which represent the three recognized horticultural races of cocoa (Enriquez et al., Cocoa Cultivars Register IICA, Turrialba, Costa Rica 1967; Engels, Genetic Resources of Cacao: A Catalogue of the CATIE Collection, Tech. Bull. 7, Turrialba, Costa Rica 1981) were obtained from the three major cocoa producing origins of the world. A list of those genotypes used in this study are shown in Table 2. Harvested cocoa pods were opened and the beans with pulp were removed for freeze drying. The pulp was manually removed from the freeze dried mass and the beans were subjected to analysis as follows. The unfermented, freeze dried cocoa beans were

first manually dehulled, and ground to a fine powdery mass with a TEKMAR Mill. The resultant mass was then defatted overnight by Soxhlet extraction using redistilled hexane as the solvent. Residual solvent was removed from the defatted mass by vacuum at ambient temperature.

TABLE 2

Description of *Theobroma cacao* Source Material

GENOTYPE	ORIGIN	HORTICULTURAL RACE
UIT-1	Malaysia	Trinitario
Unknown	West Africa	Forastero
ICS-100	Brazil	Trinitario (Nicaraguan Criollo ancestor)
ICS-39	Brazil	Trinitario (Nicaraguan Criollo ancestor)
UF-613	Brazil	Trinitario
EEG-48	Brazil	Forastero
UF-12	Brazil	Trinitario
NA-33	Brazil	Forastero

EXAMPLE 2

Cocoa Polyphenol Extraction Procedures

A. Method 1

Cocoa polyphenols were extracted from the defatted, unfermented, freeze dried cocoa beans of Example 1 using a modification of the method described by Jalal and Collin, Phytochemistry 6 1377–1380 (1978). Cocoa polyphenols were extracted from 50 gram batches of the defatted cocoa mass with 2×400 mL 70% acetone/deionized water followed by 400 mL 70% methanol/deionized water. The extracts were pooled and the solvents removed by evaporation at 45° C. with a rotary evaporator held under partial vacuum. The resultant aqueous phase was diluted to 1 L with deionized water and extracted 2× with 400 mL $CHCl_3$. The solvent phase was discarded. The aqueous phase was then extracted 4× with 500 mL ethyl acetate. Any resultant emulsions were broken by centrifugation on a Sorvall RC 28S centrifuge operated at 2,000×g for 30 min. at 10° C. To the combined ethyl acetate extracts, 100–200 mL deionized water was added. The solvent was removed by evaporation at 45° C. with a rotary evaporator held under partial vacuum. The resultant aqueous phase was frozen in liquid N_2 followed by freeze drying on a LABCONCO Freeze Dry System. The yields of crude procyanidins that were obtained from the different cocoa genotypes are listed in Table 3.

TABLE 3

Crude Procyanidin Yields

GENOTYPE	ORIGIN	YIELDS (g)
UIT-1	Malaysia	3.81
Unknown	West Africa	2.55
ICS-100	Brazil	3.42
ICS-39	Brazil	3.45
UF-613	Brazil	2.98
EEG-48	Brazil	3.15
UF-12	Brazil	1.21
NA-33	Brazil	2.23

B. Method 2

Alternatively, cocoa polyphenols may also be extracted from the defatted, unfermented, freeze dried cocoa beans of Example 1 with 70% aqueous acetone. Ten grams of defatted material is slurried with 100 mL solvent for 5–10 min. The slurry is centrifuged for 15 min. at 4° C. at 3000×g and the supernatant passed through glass wool. The filtrate is subjected to distillation under partial vacuum and the resultant aqueous phase frozen in liquid N_2, followed by freeze drying on a LABCONCO Freeze Dry System. The yields of crude procyanidins range from 15–20% of the starting material.

Without wishing to be bound by any particular theory, it is believed that the differences in crude yields reflected variations encountered with different genotypes, geographical origin, horticultural race, and method of preparation.

EXAMPLE 3

Varying the Levels of cocoa Polyphenols Via Manipulating the Degree of Fermentation

Cocoa beans (*T. cocoa*, SIAL 659) were subjected to varying degrees of fermentation by removing and analyzing samples of beans taken from a mass of fermenting beans at varying periods of time of fermentation ranging from t0 (time=zero hours) to t120 (time=120 hours). The results are shown in Table 4.

TABLE 4

Procyanidin Levels ppm (μg/g) in defatted powder with varying degrees of fermentation

	Oligomer											
SAMPLE	Monomer	Dimer	Trimer	Tetramer	Pentamer	Hexamer	Heptamer	Octamer	Nonamer	Decamer	Undecamer	Total
A - t0	21,929	10,072	10,106	7788	5311	3242	1311	626	422	146	tr	60,753
B - t24	21,088	9762	9119	7094	4774	2906	1364	608	361	176	tr	57,252
C - t48	20,887	9892	9474	7337	4906	2929	1334	692	412	302	tr	58,165
D - t96	9552	5780	5062	3360	2140	1160	464	254	138	tr	ND	27,910
E - t120	8581	4665	4070	2527	1628	888	326	166	123	tr	ND	22,974

ND = none detected
tr = trace (<50 μg/g)

EXAMPLE 4

Method of obtaining Cocoa Polyphenol Defatted Cocoa Solids from Cocoa Beans Utilizing the Inventive Process

Commercially available cocoa beans having an initial moisture content of from about 7 to 8 percent by weight were pre-cleaned using an 11"×56" Scalperator (manufactured by Carter Day International, Minneapolis, Minn., USA). Approximately 600 bags of cocoa beans (39,000 kg) were pre-cleaned over a 6.5 hour time period.

The beans were fed into the inlet hopper where the flow rate was regulated by a positive feed roll. The beans were fed onto the outside of a rotating wire mesh scalping reel. The beans passed through the wire mesh reel and subsequently through an air aspiration chamber where light dirt, dust and strings were aspirated out of the product stream. The beans that did not pass through the scalping reel were conveyed to the reject stream. This reject stream consisted of large clumps of beans, sticks, stones, etc. The amount of resultant reject was approximately 150 kg, or 0.38% of the starting material. The resulting pre-cleaned product weighed about 38,850 kg and was passed to the bean cleaning step.

The pre-cleaned bean products from the Scalperator were then further cleaned using a Camas International SV4-5 Air Fluidized Bed Density Separator (AFBDS, manufactured by Camas International, Pocotello, Ind., USA). About 38,850 kg of cocoa bean products were fed into the AFBDS over a time period of about 6.5 hours. The apparatus removed substantially all heavy impurities such as stones, metal, glass, etc. from the beans, as well as lighter unusable materials such as moldy and infested cocoa beans, resulting in a cleaned bean product which contained substantially only usable cocoa beans. The resulting heavy impurities removed weighed about 50 kg and the light unusable materials weighed about 151 kg. A total of about 38,649 kg of cleaned beans was obtained after both the pre-cleaning and cleaning steps described hereinabove (99.1% yield after cleaning).

The cleaned cocoa beans were then passed through a infra-red heating apparatus. The apparatus used was the Micro Red 20 electric infra-red vibratory Micronizer (manufactured by Micronizing Company (U.K.) Limited, U.K.). The Micronizer was run at a rate of about 1,701 kilograms per hour. The depth of beans in the vibrating bed of the Micronizer was about 2 inches or about 2–3 beans deep. The surface temperature of the Micronizer was set at about 165° C., resulting in an IBT of about 135° C., for a time ranging from 1 to 1.5 minutes. This treatment caused the shells to dry rapidly and separate from the cocoa nib. Since substantially all of the cocoa beans fed into the Micronizer were whole beans and were substantially free of small broken pieces of bean or shell, no sparks or fires were observed during the infra-red heating step. The broken pieces separated by the vibrating screen prior to the Micronizer were re-introduced into the product stream prior to the winnowing step.

The beans after the Micronizer had a moisture content of about 3.9% by weight. The beans emerged from the Micronizer at an IBT of about 135° C. and were immediately cooled to a temperature of about 90° C. in about three minutes to minimize additional moisture loss. The total beans available after the heating step was about 36,137 kg.

The beans were then subjected to winnowing using a Jupiter Mitra Seita winnower (manufactured by Jupiter Mitra Seita, Jakarta, Indonesia). The winnowing step cracked the beans to loosen the shells and separated the lighter shells from the nibs while at the same time minimizing the amount of nib lost with the shell reject stream. The feed rate into the winnower was about 1,591 kg per hour. The resultant products included about 31,861 kg of usable nibs and 4,276 kg of reject shells. The overall yield of usable nibs from starting material was about 81.7%.

The resulting cocoa nibs were pressed using a Dupps 10-6 Pressor (manufactured by The Dupps Company, Germantown, Ohio, USA). A steady, consistent feed of about 1,402 kg per hour of nibs was fed into two screw presses to extract butter. The press produced about 16,198 kg of cocoa butter which contained about 10% cocoa solids, and about 15,663 kg of cocoa solids which contained about 10% butter.

The cocoa butter was further processed using a Sharples P3000 decanting centrifuge (manufactured by Jenkins Centrifuge Rebuilders, N. Kansas City, Mo., USA). The centrifugation resulted in the removal of the solids from the butter by centrifugal forces. The centrifuging reduced the 10% solids in the butter to about 1–2% solids, and resulted in about 13,606 kg of butter and 2,592 kg of cocoa solids containing about 40 to 45% butter.

The butter containing 1–2% solids was further processed using a plate and frame filter (manufactured by Jupiter Mitra Seita) which removed the remaining solids from the butter and resulted in about 13,271 kg of clear cocoa butter and about 335 kg of cocoa solids containing 40–45% butter.

The cocoa solids removed from the centrifuge and the filter press contained about 40–45% fat and were pressed in a batch hydraulic press to produce 10% fat cocoa cake. This material produced about 1,186 kg of clear butter and 1,742 kg of cocoa solids.

The total clear butter yield from the incoming beans was 14,456 kg, or 37.1%. The total cocoa solids produced from the incoming beans was 17,405 kg, or 44.6%. The butter was subsequently tempered and packaged.

EXAMPLE 5

Method for Quantifying Cocoa Polyphenol Levels in Various Samples Processed by Conventional and Inventive Methods

Cocoa polyphenol extracts were prepared from a variety of cocoa sources (shown in Table 5) by grinding 6–7 g of sample using a Tekmar A-10 Analytical Mill for 5 min, or, in the case of liquors, from 6–7 g of chocolate liquor sample without additional grinding. The sample was then transferred to a 50 mL polypropylene centrifuge tube, approximately 35 mL of hexane was added, and sample was shaken vigorously for 1 min. Sample was spun at 3000 RPM for 10 min using an International Equipment Company IECPR-7000 Centrifuge. After decanting the hexane layer, the fat extraction process was repeated two more times. Approximately 1 g of the defatted material was weighed into a 15 mL polypropylene centrifuge tube and 5 mL of a 70% acetone: 29.5% water: 0.5% acetic acid solution was added. The sample was vortexed for about 30 sec using a Scientific Industries Vortex Genie 2 and spun at 3000 RPM for 10 min in the IECPR-7000 Centrifuge. The liquor was then filtered into a 1 ml hypovial through a Millex-HV 0.45μ filter.

Cocoa polyphenol extracts were analyzed by a Hewlett Packard 1090 Series II HPLC system equipped with a HP Model 1046A Programmable Fluorescence detector and Diode Array detector. Separations were effected at 37° C. on a 5μ Supelco Supelcosil LC-Si column (250×4.6 mm) connected to a Supelco Supelguard LC-Si 5 μm guard column (20×2.1 mm). Procyanidins were eluted by linear gradient under the following conditions: (time % A, % B, % C); (0, 82, 14, 4), (30, 67.6, 28.4, 4), (60, 46, 50, 4), (65, 10, 86, 4), followed by a 5 minute re-equilibration. Mobile phase composition was A=dichloromethane, B=methanol, and C=acetic acid:water at a volume ratio of 1:1. A flow rate of 1 mL/min was used. Components were detected by fluorescence, where λ_{ex}=276 nm and λ_{em}=316 nm, or by UV at 280 nm. Epicatechin in the concentration of approximately 1 mg/ml was used as an external standard.

HPLC conditions:

250×4.6 mm Supelco Supelcosil LC-Si column (5 μm)

20×2.1 mm Supelco Supelguard LC-Si (5 μm) guard column

Detectors: Photodiode Array at 280 nm

Fluorescence λ_{ex}=276 nm; λ_{em}=316 nm

Flow rate: 1 mL/min

Column temperature: 37° C.

Gradient	CH_2Cl_2	methanol	acetic acid/ water (1:1)
0	76	20	4
25	46	50	4
30	10	86	4

Moreover, the inventive process retained the highest level of higher oligomers, i.e., the level of pentamers from the E2 sample was 1983 ug/g as compared to 3,168 ug/g (sample #937-59) from the inventive process.

Additionally, a sample set of the following cocoa sources (a) through (d) were analyzed for cocoa polyphenols levels by the aforementioned procedure:

(a) Sulawesi raw beans prior to processing by the inventive process (RB-1),

(b) cocoa bean nibs obtained from the inventive process, according to Example 4, except as modified at the infra-red heating stage by adjusting the temperature to that which polyphenols would be conserved, i.e., approximately 100–110° C. (MN-1),

(c) two samples of cocoa solids nonfat obtained from the inventive process (MS-120 and MS-150),

(d) conventionally processed, Sulawesi raw nibs prior to processing (RN-1 and RN-2), and

(e) Sulawesi, conventionally processed partially defatted cocoa solids (CS-1 and CS-2).

The results are shown in Table 6.

TABLE 5

Polyphenols Content Defatted Dry Weight Basis

Sample	Description	Oligomer Amount (μg/g) Monomer	Dimer	Trimer	Tetramer	Pentamer	Hexamer	Heptamer	Octamer	Nonamer	Total Polyphenol
937–59	Inventive (Sulawesi unfermented screw pressed cocoa)	9433	5929	5356	4027	3168	2131	1304	739	439	32743
E1	Comparative (screw pressed cocoa cake-Sulawesi)	8713	5538	3880	2289	1553	762	372	210	60	23376
E2	Comparative (screw pressed cocoa cake-Sanchez)	8733	5564	4836	3031	1983	1099	3489	361	221	29318
E3	Comparative (screw pressed cocoa powder-Sulawesi)	7104	4915	3642	2020	1121	576	273	153	66	19871
E4	Comparative (hydraulically pressed cocoa cake-blend of origins)	7157	3981	2479	1226	583	260	87	—	—	15773
E5	Comparative (hydraulically pressed cocoa powder-blend of origins)	5811	3169	1503	537	171	55	—	—	—	11245
E6	DeZaan defatted cocoa powder - DIS - supercritical fluid extracted - alkalized unknown bean origin)	581	421	123	35	—	—	—	—	—	1161
E7	Comparative (roasted cocoa nibs - blend of origins)	2526	1551	824	206	77	64	43	—	—	5291
E8	Comparative (propane extracted cocoa nibs - blend of origins)	2904	1855	927	239	116	63	37	—	—	6140
E9	Comparative (Javabeans)	2677	2092	1645	984	632	378	240	127	93	8868
E10	Comparative (Papua New Guinea beans)	2856	1960	1672	748	318	145	74	36	—	7807
E11	Comparative (Papua New Guinea beans)	5255	3652	2402	959	485	261	159	54	—	13228
937–59	South Region, Sulawesi Liquor	1801	1205	555	114	—	—	—	—	—	3675
937–59	Southeast Region, Sulawesi Liquor	3891	2131	1213	457	150	31	—	—	—	7873
937–59	Central Region, Sulawesi Liquor	3668	1718	847	265	68	—	—	—	—	6566
CC 1	Comparative Screw Press Cake #1	2267	2034	1360	579	297	132	50	27	14	6759
CC 2	Comparative Screw Press Cake #2	2894	2313	1546	681	323	138	49	35	21	8001
CC 3	Comparative Screw Press Cake #3	2437	1878	1231	561	339	88	44	12	trace	6589

A sample set containing 9 pressed cocoa cakes, 3 cocoa meals, 3 pressed cocoa powder samples, 3 liquor samples, 3 bean samples and 2 nib samples were analyzed for procyanidin levels by the aforementioned procedure. The results are shown in Table 5. Procyanidin levels were compared to those previously reported for Sulawesi samples defatted by the inventive process. The screw pressed cocoa cake from Sanchez beans (comparative Sample No. E2) contained procyanidin levels closest to that found in the inventive processed samples, but 30% less total procyanidins.

TABLE 6

Defatted Dry Weight Basis

Sample	Description	Oligomer Amount (μg/g) Monomer	Dimer	Trimer	Tetramer	Pentamer	Hexamer	Heptamer	Octamer	Nonamer	Total Polyphenol	% Fat
RB-1	Raw Beans, Sulawesi	11354	5924	4643	3180	2181	1143	529	305	165	31425	48.0
MN-1	Inventive nibs (RB-1 = starting material)	13129	5909	4034	2120	1334	792	441	160	94	28014	47.1
MS-120	Inventive solids @ 120 psi (RB-1 = starting material)	15301	6592	4447	2526	1507	721	360	219	139	31811	11.9

TABLE 6-continued

Defatted Dry Weight Basis

Sample	Description	Oligomer Amount (μg/g) Mon-omer	Dimer	Trimer	Te-tramer	Pen-tamer	Hex-amer	Hep-tamer	Oc-tamer	Non-amer	Total Polyphenol	% Fat
MS-150	Inventive solids @ 150 psi (RB-1 = starting material)	10025	5560	4839	3245	2106	1139	542	284	214	27955	11.1
RN-1	Raw nibs, Sulawesi	7976	5643	5426	4185	3021	1806	1150	624	360	30192	48.5
CS-1	Conventional solids, Sulawesi	10527	4887	2969	1585	691	267	35	26	trace	20986	25.8
RN-2	Raw nibs, Sulawesi	12219	7635	7202	5619	4014	2384	1471	751	406	41701	47.3
CS-2	Conventional solids, Sulawesi	10170	4863	2802	1333	254	182	128	37	40	19811	26.3

Oligomer amount have been rounded to the nearest whole number; total polyphenols may include additional polyphenols above nonamer.
The total polyphenol amounts for MS-120 represent nearly 100% recovery by inventive process.
The total polyphenol amounts for MS-150 represent nearly 89% recovery by inventive process.

Polyphenols extracted from inventive solids such as RB-1 and MS-120 can be purified by preparative normal phase chromatography by modifying the method of Rigaud et al., (1993) J. Chrom. 654: 255–260. Separations are affected at ambient temperature on a 5 u Supelcosil LC-Si 100A column (50×2 cm), with an appropriate guard column. Procyanidins are eluted by a linear gradient under the following conditions: (time, % A, % B, flow rate); (0, 92.5, 7.5, 10); (10, 92.5, 7.5, 40); (30, 91.5, 18.5, 40); (145, 88, 22, 40); (150, 24, 86, 40); (155, 24, 86, 50); (180, 0, 100, 50). Prior to use, the mobile phase components can be mixed by the following protocol:

Solvent A preparation (82% methylene chloride, 14% methanol, 2% acetic acid, 2% water):

1. Measure 80 ml of water and dispense into a 4 L bottle.
2. Measure 80 ml of acetic acid and dispense into the same 4 L bottle.
3. Measure 560 ml of methanol and dispense into the same 4 L bottle.
4. Measure 3280 ml of methylene chloride and dispense into the same 4 L bottle.
5. Cap the bottle and mix well.
6. Purge the mixture with high purity Helium for 5 to 10 minutes to degas.

Repeat 1 to 6 two times to yield 8 volumes of solvent A.

Solvent B preparation (96% methanol, 2% acetic acid, 2% water):

1. Measure 80 ml of water and dispense into a 4 L bottle.
2. Measure 80 ml of acetic acid and dispense into the same 4 L bottle.
3. Measure 3840 ml of methanol and dispense into the same 4 L bottle.
4. Cap the bottle and mix well.
5. Purge the mixture with high purity helium for 5 to 10 minutes to degas.

Steps 1 to 5 can be repeated to yield four (4) volumes of solvent B. Mobile phase composition can be A=methylene chloride with 2% acetic acid and 2% water; B=methanol with 2% acetic acid and 2% water. The column load can be 0.7 g in 7 ml. Components can be detected by UV at 254 nm.

By this method, procyanidins can be obtained from the inventive solids.

As evidenced by the total polyphenol compositions obtained from RB-1, MN-1, MS-120 and MS-150, the inventive process affords at least 70% conservation, even at least 85% conservation (e.g., 85–89% see MS-150) and as much as at least 95% conservation (e.g., 95–100%; see MS-120) of the polyphenols concentration; whereas, the conventional processes result in approximately (less than 50%) to less than 70% conservation of the polyphenols concentration (see CS-1, CS-2).

Further, RN-1 and RN-2 represent varying concentrations of brown beans (or well fermented beans) in the composition starting material, such that, RN-1 was derived from a bean stock containing approximately 25% brown beans, and RN-2 was derived from a bean stock containing approximately 10% brown beans. As evidenced by the total polyphenol concentrations obtained from each of these sources, it is evident that the concentration of brown beans present in the starting bean stock is inversely proportional to the total polyphenols concentration that may be obtained from such a source, such that those samples derived from bean stocks containing a high percentage of brown beans will yield a relatively low amount of polyphenols (and conversely, slaty and/or purple beans which are less fermented will yield a relatively high amount of polyphenols).

The percentage fat of each composition in Table 6 was also determined. The inventive process obtained levels of fat which are comparable to that derived from conventional methods.

EXAMPLE 6

Cocoa Bean Winnowing Using An Air Fluidized-Bed Density Separator

An air fluidized bed density separator (AFBDS) manufactured by Camas International was tested to determine its effectiveness as a cocoa bean winnower. A blend of beans from West Africa and Central America were heated at about 150° C. for about 4 minutes to loosen the shell and were cracked with a centrifugal bean breaker. The cracked beans were separated by the AFBDS which resulted in a shell in nib level of between 0.29 to 0.99% and a nib in shell level of between 6.7 to 8.7%. Although the shell in nib level was acceptable, it was observed that a significant portion of the nibs in the shell was a result of pieces of nib which remained in the large pieces of shell. The large pieces of shell, resembling cracked eggshells, were conveyed on the top of the separation chamber. These shells typically had large pieces of nib entrapped within them which conveyed the nibs into the shell stream. To reduce this nib loss, a system for decreasing the size of the shell pieces was required which did not also decrease the size of the nibs.

A follow-up trial consisted of screening the flow of material between the second and third chamber of the AFBDS. This material was separated with a vibrating screen

with a 0.375 inch screen opening. The screen successfully removed the large pieces of shell from the material with virtually no loss of nibs. The material which passed through the screen was introduced back into the third separation chamber and the shells and nibs were subsequently separated in the chamber. The amount of shell in nib was found to be very low, however there remained a loss of small nib in the shell stream.

To reclaim the nib in shell from the third chamber, another vibrating screen was utilized with a 0.11 inch screen opening size. This screen successfully separated the remaining nib from the shell.

The fourth chamber is typically used to remove heavy impurities such as rocks, stones, etc. As a winnower, this chamber would not be required as the winnower will typically receive material which is free of these materials. In practice, the 5% flow into the fourth chamber would be passed through chamber one and onto chamber two and three.

Table 7 is a summary of the performance of the AFBDS as a winnower:

TABLE 7

Air Fluidized Bed/Vibratory Screen Winnowing Results

	% of Flow	% Shell in Nib	% Nib in Shell
Chamber 1	65	0.020	0
Chamber 2	20.0	0.002	0
0.375 in. screen			<0.1
Chamber 3	9.5	0.020	0.0
0.11 inch screen	0.5	0.075	0.99
Chamber 4	5.0	0	0
TOTAL	100	0.117	<1.09
CONVENTIONAL WINNOWING		1.75 max, 1.00 typical	range of 4–8%

% of Nib refers to the amount of the clean nib that was taken out in each chamber

As can be seen from the results above, the AFBDS can be used as a winnower and provide separations much finer than conventional winnowing processes. The use of an AFBDS surprisingly meets the FDA requirements for the amount of shell in the nib product, and has a very high yield of nib.

EXAMPLE 7

Method of Obtaining Chocolate Liquor from Underfermented Cocoa Beans According to One Embodiment of the Invention

Commercially available Sanchez cocoa beans having an initial moisture content of 7.9% by weight were used for processing. A cut test was performed on 300 of the beans and categorized the beans as 43.7% slaty, 13.0% purple, 22.0% purple-brown, and 17.7% brown. The beans had a fermentation factor of about 210.

The beans were heat treated using an FMC Link Belt Roaster. Three batches of approximately 50 kg of the beans were separately fed at a rate of 1.5 kg/min through the roaster with a residence time of 22 minutes. The degree of roast was varied in the three 50 kg batches by controlling the air temperature in the Link Belt at 127° C., 159° C., and 181° C. The resulting internal bean temperatures (IBTs) as well as the final bean moistures for each batch are listed in Table 8. The roasted beans were cracked and winnowed in a Bauermeister Cracker/Fanner (Machine #37100) to separate the cocoa nibs from the shells. A sample of the nibs collected was analyzed for oligomer content, as also shown in Table 8.

The roasted Sanchez cocoa nibs were then fed through a Carle & Montanari Mill at a rate of 2.9 kg/min to grind the nibs into chocolate liquor. In the mill, nibs dropped from a feed hopper into a narrow space between stationary and rotating grinding plates, reducing the particle size to a few hundred microns and releasing the fat contained within the nib. The pre-milled liquor was collected for analysis and subjected to further processing. The process temperature, moisture, and oligomer content of the pre-milled liquor were measured and are reported in Table 8.

The pre-milled liquor was then processed in 10 kg batches in a Szegvari Q1 Circulation Attritor Ball Mill for 20 minutes per batch to further reduce the particle size and effect fat release. The pre-milled liquor was pumped through the milling chamber. The milling chamber overflowed into an agitated recirculation tank, from which liquor was continuously pumped back into the milling chamber. The finished liquor was collected for analysis. The process temperature, moisture, and oligomer contents of the finished liquor were measured and are shown in Table 8.

TABLE 8

Unfermented Bean Process Results

	Product Temperature	Percent Moisture	Pentamer Content Defatted	Total Procyanidin Defatted	Pentamer Content Total Weight	Total Procyanidin Total Weight
127° C. Roast Nibs	119° C., IBT	4.5%	3487 μg/g	43800 μg/g	1953 μg/g	24618 μg/g
Pre-milled Liquor	95° C.	2.4%	3110 μg/g	43579 μg/g	1555 μg/g	21790 μg/g
Finished Liquor	82° C.	2.3%	3886 μg/g	47421 μg/g	1943 μg/g	23710 μg/g
159° C. Roast Nibs	142° C., IBT	2.4%	1157 μg/g	30334 μg/g	810 μg/g	21234 μg/g
Pre-milled Liquor	92° C.	1.4%	1311 μg/g	32589 μg/g	655 μg/g	16294 μg/g
Finished Liquor	59° C.	1.4%	1453 μg/g	33653 μg/g	727 μg/g	16826 μg/g

TABLE 8-continued

	Unfermented Bean Process Results					
	Product Temperature	Percent Moisture	Pentamer Content Defatted	Total Procyanidin Defatted	Pentamer Content Total Weight	Total Procyanidin Total Weight
181° C. Roast Nibs	162° C., IBT	1.3%	607 μg/g	18266 μg/g	425 μg/g	12786 μg/g
Pre-milled Liquor	83° C.	0.83%	604 μg/g	20656 μg/g	302 μg/g	10328 μg/g
Finished Liquor	59° C.	0.89%	815 μg/g	23312 μg/g	408 μg/g	11656 μg/g

to 162° C.), the level of total procyanidin decreases from 24,618 μg/g to 12,786 μg/g. The decrease is particularly pronounced with the higher oligomers, e.g. the pentamer level decreases from 1,953 μg/g to 425 μg/g. Accordingly, the roasting temperature is an important factor in the retention of cocoa polyphenols, especially the higher oligomers.

EXAMPLE 8

Method of obtaining Chocolate Liquor from Fermented Cocoa Beans Utilizing Another Embodiment of the Invention Process

Commercially available West African cocoa beans having an initial moisture content of 6.7% by weight were heat treated using an FMC Link Belt Roaster. A cut test performed on 300 of the beans categorized them as 2.7% slaty, 1.6% purple, 25.7% purple-brown, and 70.0% brown. The beans had a fermentation factor of 363. Three batches of approximately 50 kg of the beans were fed at a rate of 1.5 kg/min through the roaster with a residence time of 22 minutes. The degree of roast was varied in three 50 kg batches by controlling the air temperature in the Link Belt at 131° C., 156° C., and 183° C. The resulting internal bean temperatures (IBTs) as well as the final bean moistures for each batch are listed in Table 9. The roasted beans were cracked and winnowed in a Bauermeister Cracker/Fanner (Machine #37100) to separate the cocoa nibs from the shells. A sample of the nibs collected was analyzed for oligomer content, as shown in Table 9.

The roasted West African cocoa nibs were then fed through a Carle & Montanari Mill at a rate of 2.9 kg/min to grind the nibs into liquor. In the mill, the nibs dropped from a feed hopper into a narrow space between stationary and rotating grinding plates, reducing the particle size to few hundred microns and releasing the fat contained within the nib. The pre-milled liquor was collected for analysis and subjected to further processing. The process temperature, moisture, and oligomer content of the pre-milled liquor were measured and are reported in Table 9.

The West African pre-milled liquor was then processed in 10 kg batches in a Szegvari Q1 Circulation Attritor Ball Mill for 20 minutes per batch to further reduce the particle size and effect fat release. The pre-milled liquor was fed through the milling chamber. The milling chamber overflowed into an agitated recirculation tank, from which liquor was continuously pumped back into the milling chamber until a conventional particle size was reached. The finished liquor was collected for analysis. The process temperature, moisture, and oligomer content of the finished liquor were measured and are shown in Table 9.

TABLE 9

	Fermented Bean Process Results					
	Product Temperature	Percent Moisture	Pentamer Content Defatted	Total Procyanidin Defatted	Pentamer content Total Weight	Total Procyanidin Total Weight
131° C. Roast Nibs	121° C., IBT	2.2%	804 μg/g	10227 μg/g	402 μg/g	8181 μg/g
Pre-milled Liquor	94° C.	1.9%	904 μg/g	11506 μg/g	452 μg/g	5753 μg/g
Finished Liquor	61° C.	1.8%	865 μg/g	11298 μg/g	432 μg/g	5649 μg/g
156° C. Nibs	141° C., IBT	1.6%	313 μg/g	7631 μg/g	156 μg/g	5889 μg/g
Pre-milled Liquor	85° C.	1.2%	275 μg/g	7414 μg/g	138 μg/g	3707 μg/g
Finished Liquor	62° C.	1.2%	324 μg/g	7844 μg/g	162 μg/g	3922 μg/g
183° C. Roast Nibs	163° C., IBT	0.85%	124 μg/g	5631 μg/g	62 μg/g	2815 μg/g
Pre-milled Liquor	73° C.	0.51%	222 μg/g	6529 μg/g	111 μg/g	3265 μg/g
Finished Liquor	69° C.	0.73%	246 μg/g	6610 μg/g	123 μg/g	3305 μg/g

As shown in Table 9, as the temperature of the roast is increased from 131° C. to 183° C. (or the IBT from 121° C. to 163° C.), the level of total procyanidin decreases from 8,181 μg/g to 2,815 μg/g. The decrease is particularly pronounced at with the higher oligomers, e.g. the pentamer level decreases from 402 μg/g to 62 μg/g. Accordingly, the roasting temperature is an important factor in the retention of cocoa polyphenols, especially the higher oligomers, when roasting both underfermented (Example 7) and fermented (Example 8) cocoa beans.

The liquor produced in Example 8 could be further-processed into cocoa butter and cocoa powder. The cocoa solids would contain a high level of the procyanidins. Processing the liquor to butter and powder could be accomplished using a hydraulic press such as manufactured by Carle and Montanari. The liquor from Example 8 could be heated to 200 to 215° C. The liquor is then pumped into the press pots. When the pots are filled with liquor, the hydraulic ram is activated. Cocoa butter is squeezed through very fine mesh screens. The resultant products are cocoa cake and cocoa butter. The nonfat cocoa solids contained in the cocoa cake would have the same amount of procyanidins as were present in the initial liquor. The cocoa cake produced via this process could be used in edible products.

EXAMPLE 9

A Method of Infra-red Heating Cocoa Beans to Produce a Chocolate Liquor Containing Increased Levels of Cocoa Polyphenols

Fair average quality (FAQ) Sulawesi cocoa beans having an initial moisture content 7.4% by weight and a fermentation factor level of 233 (31% slaty, 29% purple, 22% purple brown and 17% brown) were selected as the starting material. The cocoa beans were then passed through an infra-red heating apparatus. The apparatus used was an infra-red gas vibrating micronizer (manufactured by Micronizer Company (U.K.) Limited, U.K.). The feed rate of beans through the infra-red heater and the infra-red heater bed angle were varied to control the amount of heat treatment the beans received. The amount of time the beans spent in the infra-red heater (residence time) was determined by the bed angle and the feed rate. The times used to prepare the example material are listed in the Table 10 below. At the outlet of the micronizer the IBT of the beans was measured, these values are also shown in Table 10. The surface temperature of the beans exiting the infra-red heater are higher than the IBT. Rapid surface cooling brings the surface temperature close to the IBT in less than 1 minute. The traditional purpose of infra-red heating is to heat the whole beans and loosen the shell from the nib. In the example, the micronizer was used to roast the Sulawesi beans in a novel fashion by increasing the thermal load on the beans, i.e., high temperature short time (HTST). No fires were observed in the Micronizer during the infra-red heating. A total of 25 kg of raw beans were infra-red heated at each set point.

The infra-red heated beans were further processed into chocolate liquor. This liquor was produced using lab scale liquor processing equipment. The same processing could be done using the plant size equipment referenced in Example 7. A 1 kg sample of infra-red heated beans collected off the infra-red heater at different IBTs were cracked into smaller pieces. This is done to facilitate the separation of the nib from the shell. The laboratory piece of equipment used to remove the shell was the Limiprimita Cocoa Breaker made by the John Gordon Co. LTD. of England. The cracked beans were next passed through a laboratory scale winnowing system. The piece of equipment used was the Catador CC-1 made by the John Gordon Co. LTD of England. The result of this processing was that the shells and nibs were separated.

The cocoa nibs were next milled into a coarse liquor. This was accomplished using a Melange made by Pascall Engineering Co. LTD England. This device crushes and grinds the nibs into a chocolate liquor. The normal operating temperature for the liquor in the Melange in approximately 50° C. This same process of taking nibs to a coarse liquor could be done on a larger production scale using the Carle & Montanari Mill mentioned in Example 7. The cocoa nibs were ground in the Melange for one hour in each experiment. This cycle time was sufficient to convert the nibs to a liquor. The content of cocoa polyphenols was measured for the samples relating to the infra-red heated temperatures. These values are contained in the Table 10 below.

TABLE 10

IBT° C.	Residence Time in Micronizer, Seconds	% Moisture in Finished Liquor	μg/g Pentamer in Defatted Liquor	μg/g of Total Polyphenols in Defatted Liquor
107	42	3.9	3,098	39,690
126	82	1.87	1,487	28,815
148	156	1.15	695	23,937

As shown in Table 10, as the internal bean temperature of the cocoa bean is increased from 107° C. to 148° C., the level of total procyanidin decreases from 39,690 μg/g to 23,937 μg/g. The decrease is particularly pronounced at with the higher oligomers, e.g. the pentamer level decreases from 3,098 μg/g to 695 μg/g. Accordingly, the internal bean temperature of the cocoa bean resulting from any heating is an important factor in the retention of cocoa polyphenols, especially the higher oligomers.

EXAMPLE 10

Standard of Identity (SOI) and Non-Standard of Identity (non-SOI) Dark and Milk Chocolate Formulations

Formulations of the compounds of the invention or combination of compounds derived by methods embodied in the invention can be prepared into SOI and non-SOI dark and milk chocolates as a delivery vehicle for human and veterinary applications. The cocoa polyphenol solids of Example 4 are used as a powder or liquor to prepare SOI and non-SOI chocolates, beverages, snacks, baked goods, and as an ingredient for culinary applications.

The following describes the processing steps used in preparing these chocolate formulations.

Process for non-SOI Dark Chocolate

1. Batch all the ingredients excluding 40% of the free fat (cocoa butter and anhy. milk fat) maintaining temperature between 30–35° C.
2. Refine to 20 microns.
3. Dry conche for 1 hour at 35° C.
4. Add full lecithin and 10% cocoa butter at the beginning of the wet conche cycle; wet conche for 1 hour.
5. Add all remaining fat, standardize if necessary and mix for 1 hour at 35° C.
6. Temper, mould and package chocolate.

Process for SOI Dark Chocolate

1. Batch all ingredients excluding milk fat at a temperature of 60° C.

2. Refine to 20 microns.
3. Dry conche for 3.5 hours at 60° C.
4. Add lecithin and milk fat and wet conche for 1 hour at 60° C.
5. Standardize if necessary and mix for 1 hour at 35° C. Temper, mould and package chocolate.

Process for non-SOI Milk Chocolate

1. Batch sugar, whole milk powder and 66% of the cocoa butter, conche for 2 hours at 75° C.
2. Cool batch to 35° C. and add cocoa powder, vanillin, chocolate liquor and 21% of cocoa butter, mix 20 minutes at 35° C.
3. Refine to 20 microns.
4. Add remainder of cocoa butter, dry conche for 1.5 hour at 35° C.
5. Add anhydrous milk fat and lecithin, wet conche for 1 hour at 35° C.
6. Standardize, temper, mould and package the chocolate.

Process for SOI Milk Chocolate

1. Batch all ingredients excluding 65% of cocoa butter and milk fat at a temperature of 60° C.
2. Refine to 20 microns.
3. Dry conche for 3.5 hours at 60° C.
4. Add lecithin, 10% of cocoa butter and anhydrous milk fat; wet conche for 1 hour at 60° C.
5. Add remaining cocoa butter, standardize if necessary and mix for 1 hour at 35° C.
6. Temper, mould and package the chocolate.

The cocoa polyphenols cocoa solids and commercial chocolate liquors used in the formulations were analyzed for the content of total cocoa polyphenols and cocoa polyphenol pentamer according to the method of Example 5 prior to incorporation in the formulations. These values were then used to calculate the expected levels in each chocolate formula. In the cases for the non-SOI dark chocolate and non-SOI milk chocolate, the products were similarly analyzed for the content of total cocoa polyphenols and cocoa polyphenol pentamer. The results are shown in Tables 11 and 12.

TABLE 11

Dark Chocolate Formulas Prepared with non-Alkalized Cocoa Ingredients

Non-SOI Dark Chocolate Using Cocoa Polyphenols Part. Defat Cocoa Solids Formulation:	SOI Dark Chocolate Using Cocoa Polyphenol Cocoa Solids Nonfat Formulation:	SOI Dark Chocolate Using Commercial Cocoa Solids Nonfat Formulation:
41.49% Sugar	41.4% sugar	41.4% sugar
3% whole milk powder	3% whole milk powder	3% whole milk powder
26% cocoa polyphenol cocoa powder	52.65% cocoa polyphenol liquor	52.65% chocolate liquor
4.5% chocolate liquor	2.35% anhy. milk fat	2.35% anhy. milk fat
21.75% cocoa butter	0.01% vanillin	0.01% vanillin
2.75% anhy. milk fat	0.5% lecithin	0.5% lecithin
0.01% vanillin		
0.5% Lecithin		
Total fat: 31%	Total fat: 31%	Total fat: 31X
Particle size: 20 microns	Particle size: 20 microns	Particle size: 20 microns
Expected Levels of pentamer and total oligomer procyanidins (monomers and n = 2–12; units of ug/g)		
Pentamer: 1205	Pentamer: 1300	Pentamer: 185
Total: 13748	Total: 14646	Total: 3948
Actual Levels of pentamer and total oligomer procyanidins (monomers and n = 2–12; units of ug/g)		
Pentamer: 561	Not performed	Not performed
Total: 14097		

TABLE 12

Milk Chocolate Formulas Prepared with non-Alkalized Cocoa Ingredients

Non-SOI Milk Chocolate Using Cocoa Polyphenol Cocoa Solids Formulation:	SOI Milk Chocolate Using Cocoa Polyphenol Cocoa Solids Formulation:	SOI Milk Chocolate Using Commercial Cocoa Solids Formulation:
46.9965% Sugar	46.9965% sugar	46.9965% sugar
19.5% whole milk powder	19.5% whole milk powder	19.5% whole milk powder
4.5% cocoa polyphenol cocoa powder	13.0% cocoa polyphenol liquor	13.9% chocolate liquor
5.5% chocolate liquor	1.6% anhy. milk fat	1.60% anhy. milk fat
21.4% cocoa butter	0.0035% vanillin	0.0035% vanillin
1.6% anhy. milk fat	0.5% lecithin	0.5% lecithin
	7.5% cocoa butter	17.5% cocoa butter

TABLE 12-continued

Milk Chocolate Formulas Prepared with non-Alkalized Cocoa Ingredients		
0.035% vanillin 0.5% lecithin Total fat: 31.75% Particle size: 20 microns	Total fat: 31.75% Particle size: 20 microns	Total fat: 31.75% Particle size: 20 microns
Expected Levels of pentamer and total oligomer procyanidins (monomers and n = 2–12; units of μg/g)		
Pentamer: 225 Total: 2734	Pentamer: 343 Total: 3867	Pentamer: 49 Total: 1042
Actual levels of pentamer and total oligomer procyanidins (monomers and n = 2–12; units of μg/g)		
Pentamer: 163 Total: 2399	Not performed	Not performed

EXAMPLE 11

Dry Drink Mix with Cocoa Powder Containing Enhanced Levels of Cocoa Polyphenol

A dry drink mix containing the cocoa powder of Example 4 having enhanced levels of cocoa polyphenols was made according to the following formulation:

Ingredient	%
Sucrose	65.0667
Malt Powder	11.9122
Cocoa Polyphenol Rich Cocoa Powder	18.0185
Alkalized Cocoa Powder	4.0041
Vanillin	0.0025
Lecithin	0.9960
	100.00

The dry ingredients were batched according to the above formulation and mixed for one hour in a Kitchen Aid Professional Mixer (Model KSM50P) using a wire whip at #2 speed. The lecithin was agglomerated prior to use in the recipe in a Niro-Aeromatic Agglometer (Model STREA/1).

The dry drink mix was evaluated according to the method of Example 5 and found to have the following cocoa polyphenol content:

Pentamer Content: 221 μg/g
Total Polyphenolic Content: 4325 μg/g

Two tablespoons of the dry drink mix (30 g) were added to milk (8 ounces, 2% fat) to form a chocolate flavored drink.

EXAMPLE 12

Savory Sauce with Chocolate Liquor Containing Enhanced Levels of Cocoa Polyphenol

A mole sauce containing the chocolate liquor of Example 7 containing enhanced levels of cocoa polyphenol was made according to the following formulation:

Ingredient	%
Chili Powder	2.4
Olive Oil	4.8
Cumin	0.39
Cinnamon	0.21
Stewed Tomatoes	90.8
Chocolate Liquor (from Example 7)	1.4
	100.00

The oil and spices were heated in a MAGNALite saucepan (41/4.5 qt.) on a HOTPOINT stove (Model RS744G0N1BG) over medium high heat (product temperature 102° C.) for about 20 seconds. The stewed tomatoes and liquor were added to the oil/spice mixture and cooked at a product temperature of 85° C. for 5 minutes.

The sauce was evaluated according to the method of Example 5 and found to have the following cocoa polyphenol content:

Pentamer Content: Trace Total Polyphenolic Content: 213 μg/g

One skilled in the art would readily appreciate how to modify the recipe, for example by adding more chocolate liquor, to obtain a product with higher cocoa polyphenol content, particularly a higher pentamer content.

EXAMPLE 13

Cereal Product with Cocoa Powder Containing Enhanced Levels of Cocoa Polyphenol

A cereal was made according to the following formulation:

Ingredient	%
Soft Wheat Flour	37.09
Hard Wheat Flour	16.64
Sugar, Granulated	30.33
Sodium bicarbonate	0.19
Monocalcium Phosphate	0.19
Glycerol Monostearate	0.43

-continued

Ingredient	%
Salt	1.73
Cocoa Powder (from EX. 4)	13.40
	100.00

All of the ingredients except the cocoa powder were combined in a small ribbon blender and blended 3 minutes. At the end of the mixing cycle, all of the blended materials were pneumatically conveyed to an AccuRate Feeder. The dry blend was fed through the AccuRate Feeder at 40 kg/hr, along with the cocoa polyphenol cocoa powder, which was fed through the K-tron Feeder at 6.18 kg/hr, into a Werner-Pfleiderer Twin Screw Extruder (Model ZSK57 with Bullet Tips). Water was added at a rate of 1.2 l/hr. The extruder was started up using standard operating procedures. Feed rates for dry blend and water were adjusted to targets. The screw RPM was set to 200. The cocoa feeder was adjusted to target and cereal tubes were collected. Empty cereal tubes were fed through the crimper and collected in 2 foot lengths. Separate pillows were made by snapping at crimped edges.

Results:
Pentamer Content: 23 μg/g
Total Polyphenolic Content: 3453 μg/g

EXAMPLE 14

Cooked Vanilla Pudding made with Cocoa Polyphenol Extract

A standard cooked vanilla pudding was made according to the following formulation:

Ingredient	%
JELL-O Vanilla Pudding Mix	95.00
Cocoa Polyphenol Extract	5.00
	100.00

The pudding was cooked according to the following procedure:

The cocoa polyphenol extract was made according to the extraction process of Example 2 (method 1) and finely ground using a Hamilton Beach Blendmaster blender (Model #50100, type B12). Five percent of the extract was added to the dry-pudding mix and blended using a wire whip. Two cups of whole milk were added to the pudding mixture in a MAGNA Lite saucepan. The dry mixture and milk were cooked and stirred constantly using a wire whip over medium heat on a HOTPOINT stove (Model RS744G0N1BG) until the mixture came to a full boil. The pudding was removed from the heat, poured into a storage container, and stored in the refrigerator.

Results:
Pentamer Content: 70 μg/g
Total Polyphenolic Content: 1559 μg/g

EXAMPLE 15

Brownies with Chocolate Liquor Containing Enhanced Levels of Cocoa Polyphenol

Brownies were made using the chocolate liquor of Example 7 to replace the unsweetened chocolate of a conventional recipe, according to the following formulation:

Ingredient	%
Shortening	12.50
Chocolate Liquor	9.41
Sugar	37.60
All Purpose Flour	23.48
Baking Powder	.14
Salt	.14
Eggs	16.60
Vanilla	.13
	100.00

The following procedure was used to make the brownies:

Cocoa polyphenol chocolate liquor and shortening were placed into a Kitchen Aid K45 bowl. The bowl was then placed on top of a MAGNA Lite Saucepan (4 1/4.5 qt.), which had 345 grams of boiling (100° C.) water in it. This double boiler was then heated on a HOTPOINT stove (Model #RS744G0N1BG) over low heat until melted, and was removed from heat. The sugar, eggs and vanilla were mixed into the melted mixture. The remaining dry ingredients were mixed in and the dough spread into a greased 13"×9"×2" baking pan. The brownies were baked at 350OF in a HOTPOINT oven (Model #RS744G0N1BG) for about 30 minutes until the brownies pulled away from the sides of the pan.

Results:
Pentamer Content: 97 μg/g
Total Polyphenolic Content: 2981 μg/g

EXAMPLE 16

Chocolate Cookies with Cocoa Powder Containing Enhanced Levels of Cocoa Polyphenol

Chocolate cookies were made using the cocoa powder of Example 4 according to the following formulation:

Ingredient	%
Soft Butter	30.50
Confectioner's Sugar	7.60
Unsifted Flour	45.80
Cocoa Polyphenol Cocoa Powder	15.30
Water	.35
Vanilla Extract	.45
	100.00

The process outlined below was used to make the cookies:

The oven was pre-heated to 325° F. The butter and one-fourth of the sugar were creamed in a Kitchen Aid Model KSM90 for about 2 minutes. The remaining ingredients were added and mixed well (approx. 3 minutes). The dough was shaped into small balls and put on an ungreased cookie sheet. Cookies were baked at 325° F. for 15–17 minutes.

Results (After Baking):
Pentamer Content: 46 μg/g
Total Polyphenolic Content: 3841 μg/g

EXAMPLE 17

Rice and Sauce Mix with Cocoa Polyphenol Extract

A rice and sauce mix is prepared using the formulation below:

Ingredient	%
Seasoning Mix w/Cheese	11.00
Dried Vegetables	2.00
Dry Rice	83.00
Cocoa Polyphenol Extract	4.00
	100.00

All of the ingredients are combined in a saucepan on the stove, and are brought to a boil. Once the mixture is boiling, the heat is reduced and the mixture is simmered for about 10 minutes.

Theoretical results assuming no loss during processing:
Pentamer Content: 1190 μg/g
Total Polyphenolic Content: 15,000 μg/g

A rice and cheese sauce mix is prepared using the formulation below:

Ingredient	%
Seasoning Mix w/Cheese	22.00
Dried Vegetables	3.00
Dry Rice	71.00
Cocoa Polyphenol Extract	4.00
	100.00

All of the ingredients are combined in a saucepan with 2¼ cups water and 1 to 2 tablespoons of butter. The mixture is brought to a boil and then is allowed to simmer for about 10 minutes, until most of the water is absorbed. The rice mix is then allowed to sit for about 5 minutes to allow the cheese sauce to thicken.

Theoretical results assuming no loss during processing:
Pentamer Content: 1190 μg/g
Total Polyphenolic Content: 15000 μg/g

EXAMPLE 18

Extruded Energy Bar Process with Cocoa Powder Having Enhanced Levels of Cocoa Polyphenol

Energy Bars were made using the cocoa powder of Example 4 having enhanced levels of cocoa polyphenol in place of natural cocoa powder, according to the following recipe:

Ingredient	%
Carbohydrate Syrup	20–30
Fruit/Fruit Preparation	10–15
Protein Powder (milk or soy origin)	5–20
Micronutrients	4–5
Simple Sugars	10–20
Maltodextrin	10–15
Crisp Rice/Rice	10–13
Cocoa Polyphenol Cocoa Powder	8–12
Fat	2–5
Flavor	0.1–1.5

The ingredients were mixed in a JH Day 50 gallon jacketed stainless steel double arm sigma blade mixture. The mixer jacket was set to 50° C. The carbohydrate syrup, fat, and fruit/fruit preparation was combined in the mixer and mixed at 50 rpm until homogenous, about 5 minutes. With the mixer running, the remaining ingredients were gradually added in the following order and blended until homogenous; micronutrients, flavor, cocoa powder, simple sugars, maltodextrin, protein powder, and crisp rice/rice. The blended energy bar mass was transferred to the hopper of the Werner Lehara Continuous Rope Extruder. The extruder was jacketed at 40° C. to keep the mass soft and pliable for forming. The mass was extruded through the nozzle block onto a conveyor belt that transferred the strips through a cooling tunnel. A guillotine was used to cut the bars to length upon exiting the cooling tunnel at 15–20° C.

Results:
Pentamer Content: 22 μg/g
Total Polyphenolic Content: 1710 μg/g

EXAMPLE 19

Baby Food containing Cocoa Polyphenol Extract

A vegetable baby food containing cocoa polyphenol extract is prepared using the following formulation:

Ingredient	Example 19A (%)	Example 19B (%)
Vegetable[A]	73	60
Liquid[B]	22	35
Cocoa Polyphenol Extract	5	5

Ingredient (A): Potatoes, green beans, peas, carrots, and yellow squash.
Ingredient (B): Cooking liquid, formula, or water.

Vegetables are cooked by steaming, microwave oven, or boiling (using small amounts of water which are retained for thinning the pureed food). After cooking, all ingredients are mixed together, placed in a blender and pureed until a smooth consistency is reached.

Theoretical results assuming no loss during processing:
Total Pentamer Content: 1488 μg/g
Total Polyphenolic Content: 18758 μg/g

EXAMPLE 20

Pat Food with Cocoa Powder Having Enhanced Levels of Cocoa Polyphenol

A canned dog/cat food is prepared with cocoa powder having enhanced levels of cocoa polyphenol using the following formulation:

Ingredients	Example 20A (%)	Example 20B (%)
Meat/meat by-products	68	52
Water	24	35
Cereals and grains	0	5
Colors, vitamins, minerals, gums, emulsifiers, flavorings, and preservatives	3	3
Cocoa Polyphenol Cocoa Powder	5	5

The mixture of meats, animal by-products, cereal components and cocoa polyphenol cocoa powder are hermetically sealed in metal or plastic containers and processed at

temperatures and pressures sufficient to render them commercially sterile. The product is heat treated in hermetically sealed containers with an Fo value of 3.0 or more, for canned pet food.

Theoretical results assuming no loss during processing:

Pentamer Content: 107 μg/g
Total Polyphenolic Content: 1554 μg/g

EXAMPLE 21

Dry Pet Food With Cocoa Powder Having Enhanced Levels of Cocoa Polyphenol

A dry extruded dog/cat food is prepared with cocoa powder having enhanced levels of cocoa polyphenols using the following formulation:

Ingredient	%
Grains, meat/meat by-products, meat meals	57–66
Dairy by-products	24–33
Colors, vitamins, minerals, gums, emulsifiers, flavorings, and preservatives	3
Cocoa Polyphenol Cocoa Powder	5

The meal is processed in a continuous cooking extruder for approximately 20 seconds reaching 145° C. for approximately 10 seconds. The wet-formed pieces of pet food are dried by means of a conventional belt dryer subjected to air temperatures of 125° C. for approximately 10 minutes. The product is then coated with animal fat and/or emulsified, hydrolyzed animal tissue.

Theoretical results assuming no loss during processing:

Pentamer Content: 107 μg/g
Total Polyphenolic Content: 1554 μg/g

EXAMPLE 22

Chocolate syrup With Cocoa Polyphenol Cocoa Powder

A chocolate variegating and sundae topping syrup containing the cocoa polyphenol cocoa powder are prepared using the following formula:

Ingredients	Economy Formula (%)	Premium Formula (%)
Water	30.74	31.56
Corn syrup solids	35.07	30.91
Sucrose	22.20	20.94
Cocoa Polyphenol Cocoa Powder	8.88	7.98
Hydrogenated vegetable fat	0	5.98
Milk solids non-fat	2.22	1.99
CC-801*	0.72	0.49
CC-280 (emulsifier)	0.17	0.15
	100.00	100.00

*CC-801 (Pectin, Dextrose, Sodium citrate) is added at 0.20% in the above formulas for chocolate sundae topping syrup; remainder replaced with water to 100%.

For each pound of CC-801, one gallon of water from the formula is heated to 180° F. in a small vat. The CC-801 is stirred in and is set aside until ready to homogenize the complete batch. The balance of the water is added to a steam-jacketed vat. In the following order, the sucrose, milk solids non-fat, and corn-syrup solids are incorporated. The balance of the ingredients are then added in any order. The mixture is heated to 185° F. and held for 5 minutes. The CC-801 solution is added and mixed thoroughly. The batch is at 1000 psi (if not homogenizing, increase the stabilizer 35%). The product is pumped into sanitized containers and stored in a cooler at 40° F. to allow the product to set up.

Theoretical results assuming no loss during processing:

Pentamer Content: 171 μg/g
Total Polyphenolic Content: 2486 μg/g

EXAMPLE 23

Hard Candy

Formed and deposited types of hard candy are prepared using the formulation below by the methods described in Lees & Jackson, 1st Edition, *Sugar Confectionery and Chocolate Manufacture*, pages 176–186 (1995).

Hard candy Formula	%
Sugar	42.85%
High Maltose Corn Syrup	38.09%
Water	12.19%
Buffered Lactic Acid	1.90%
Flavoring	0.19%
Coloring	0.0057%
Cocoa Polyphenol Cocoa Powder	4.77%

Theoretical results assuming no loss during processing:

Pentamer Content: 102 μg/g
Total Polyphenolic Content: 1482 μg/g

EXAMPLE 24

Rice Cake with Cocoa Polyphenol Cocoa Powder

A cocoa polyphenol cocoa powder covered rice cake was prepared using the following ingredients:

Puffed Rice Cake (made by a method similar to that set forth in U.S. Pat. No. 4,888,180)

N-Tack (corn syrup solids in 30% solution)

Cocoa Polyphenol Cocoa Powder Mix

A prepared rice cake was coated with a thin layer of N-Tack solution. The coated rice cake was immediately placed in a bag containing the cocoa polyphenol mix and coated. The cake was then shaken to remove excess cocoa polyphenol mix. The cake was given a second application of

N-Tack and mix resulting in approximately 4 grams of cocoa polyphenol mix being applied to the puffed rice cake.

	Theoretical	Actual
Pentamer Content (μg/g)	252	38
Total Polyphenolic Content (μg/g)	3655	4842

EXAMPLE 25

Fruit and Grain Pastry Bar with Cocoa Polyphenol Extract

A strawberry fruit filling was made according to the following formulation:

Ingredient	wet wt %	amount (g)
Xanthan gum, extra fine	1.0	5.0
Hydrogenated soybean oil	1.25	6.25
Water	10.0	50.0
Glycerin USP or food grade	7.0	35.0
Corn syrup solids	56.23	281.2
Maltrin M250 (78% solids with 61.9 g water)		
Low moisture apple flake powder	5.0	25.0
Natural strawberry flavor	2.0	10.0
Strawberry puree concentrate	12.0	60.0
Malic acid, fine granular	0.5	2.5
Red #40 strawberry color	0.02	0.1
Cocoa Polyphenol Extract	5.0	25.0
	100.00	500.00

For making the fruit filling, the gum was hydrated in cold water using a blender. The corn syrup solids, water, fruit puree, cocoa polyphenol extract and glycerin were cooked on a stove top using medium to high heat to a temperature of 230° F. measured with a Wahl thermocouple thermometer. The mixture was removed from the heat and allowed to cool. Hydrated gum was added to the mixture and the mixture was heated to 216° F. The mixture was again removed from the heat and allowed to cool for at least 5 minutes. Acid, color, apple powder and melted fat were added to the mixture, and the mixture was allowed to cool for 2 additional minutes. Flavor was added to the mixture with thorough mixing.

Results:

Pentamer Content: 349 μg/g

Total Polyphenolic Content: 12,771 μg/g

The pastry wrapper was made according to the following formulation:

Ingredient	wet wt %	amount (g)
Blended flour 30% hard flour (54.75 g) 70% soft flour (127.75 g)	36.5	182.5
Brown sugar roasted oats	14.6	73.0
Wheat bran	7.3	36.5
Gum arabic (Acacia FCC)	0.6	3.0
Kelco gum (Kelite CM)	0.6	3.0
Soy lecithin	0.8	4.0
Sodium bicarbonate	0.6	3.0
Sodium acid pyrophosphate	0.4	2.0
Brown sugar, granulated	6.3	31.5
Hydrogenated soybean oil	5.2	26.0
Water	21.22	106.1
Flour salt	1.0	5.0
Glycerin USP or food grade	4.1	20.5
Kelco GFS, prehydrated	0.78	3.9
	100.00	500.00

For making the pastry wrapper, the gum arabic, Kelite CM, sodium bicarbonate, sodium acid pyrophosphate, salt, Kelco GFS and glycerin were hydrated in water using a blender. Lecithin was stirred into melted fat. The remaining dry ingredients were added to a mixing bowl. The fat blend was added to the dry ingredients using a Kitchen Aid mixer on speed 2. The gum blend was slowly added into the mixing bowl. After mixing, the dough was worked by hand into a ball. The dough was proofed for 15 minutes covered with a wet paper towel to decrease stickiness. A Rondo Sheeter (Sewer Rondo, Inc. STE533) was used to achieve a dough thickness of 2.5 mm. The dough was cut into 4"×4" squares weighing 33 g.

Using a pastry bag, 19.5 g of the fruit filling was applied on top of each dough square. The dough was folded over to make a bar and the ends of the bar were sealed shut with crimping. Using a knife, holes were poked in the top of the bar to help heat escape and to prevent bar explosion.

The bars were baked for 6½ minutes at 375° F. The weight of the final, baked bar was 45.5 g.

Results:

Pentamer Content: 105 μg/g

Total Polyphenolic Content: 5,851 μg/g

EXAMPLE 26

Caramel Chew with Cocoa Powder Containing Enhanced Levels of Cocoa Polyphenol

Sample A: Cocoa Polyphenol Caramel Chew 15

Ingredients	Caramel portion (67.00%)	Cocoa/Sugar Premix (33.00%)	Final Chocolate Chew After Cooking (Dry wt. basis)
63 DE Corn Syrup	56.70		35.00
Salt	0.60		0.44
Sweetened Condensed Skim Milk	34.20		17.70
Partially Hydrogenated Soy Bean Oil 6016	8.50		6.30
Cocoa Polyphenol Cocoa 011797B		45.5	14.66
Fondant Sugar (Redi-Fond from Domino Sugar)		54.5	18.00
Water			7.90
	100.00	100.00	100.00

The caramel portion was batched according to the above formulation and combined with agitating and steam in a Groen kettle. The mixture was heated slowly with agitation to 235° F. and cooled to 200° F. or lower.

For making the finished chocolate chew, the cocoa polyphenol cocoa powder and fondant sugar were blended. The caramel portion (67.0% of the final formula) was placed in a Hobart Mixer. While mixing, the cocoa/sugar premix (33.0% of the final formula) was slowly added. The formulation was slabbed to the desired thickness (10 mm). After cooling and setting up (about 2 hours), the formulation was cut to the desired size (20 mm squares).

Results:

Pentamer Content (cocoa added at 140° F.): 95 μg/g

Total Polyphenolic Content (cocoa added at 140° F.): 2195 μg/g

Sample B: Cocoa Polyphenol Caramel Chew 22

Ingredients	Caramel portion (67.00%)	Cocoa/ Sugar Premix (33.00%)	Final Chocolate Chew After Cooking (Dry wt. basis)
63 DE Corn Syrup	56.70		35.20
Salt	0.60		0.44
Sweetened Condensed Skim Milk	34.20		17.70
Partially Hydrogenated Soy Bean Oil 6016	8.50		6.29
Cocoa Polyphenol Cocoa 011797B		66.7	21.34
Fondant Sugar		33.3	10.95
(Redi-Fond from Domino Sugar)			
Water			8.08
	100.00	100.00	100.00

The caramel portion was batched according to the above formulation and combined with agitating and steam in a Groen kettle. The mixture was heated slowly with agitation to 235° F. and cooled to 200° F. or lower.

For making the finished chocolate chew, the cocoa polyphenol cocoa powder and fondant sugar were blended. The caramel portion (67.0% of the final formula) was placed in a Hobart Mixer. While mixing, the cocoa/sugar premix (33.0% of the final formula) was slowly added. The formulation was slabbed to the desired thickness (10 mm). After cooling and setting up (about 2 hours), the formulation was cut to the desired size (20 mm squares).

Results:

Pentamer Content (cocoa added at 140° F.): 178 μg/g

Pentamer Content (cocoa added at 200° F.): 178 μg/g

Total Polyphenolic Content (cocoa added at 140° F.): 4036 μg/g

Total Polyphenolic Content (cocoa added at 200° F.): 3941 μg/g

EXAMPLE 27

Sugar Tablets with Cocoa Powder Containing Enhanced Levels of Cocoa Polylhenol

Wet process tablets were made according to the following formulation:

	Wet Cocoa Tablet	Final Cocoa Tablet After Drying (Dry wt. basis)
Sucrose - 6X	41.30	51.19
Cocoa Polyphenol Cocoa Powder	35.00	42.08
Water	21.66	4.50
Gum Arabic	1.26	1.41
Gelatin 200 Bloom	0.62	0.73
Vanilla 4X	0.76	0.09
	100.00	100.00

The gelatin was soaked in water and the sucrose was premixed with the cocoa polyphenol cocoa powder. After the gelatin is hydrated, it was heated to 90° C. and gum arabic was added with high shear. This solution, with flavor, was mixed into ¼ of the sucrose/cocoa mixture, and the remaining sucrose/cocoa was slowly added while mixing (in a Hobart or Kitchen Aid Ultra Power mixer). The formulation was mixed for 10–15 minutes and slabbed to the desired thickness (~5 mm). After drying and punching out in the desired shape (discs), the pieces were dried further to a final moisture of approximately 3–6%.

Analytical results:

Sample	Total Procyanidin microgram/ gram	Pentamers microgram /gram	moisture percent	notes
Tablet #5 with Cocoa Polyphenol 112696M	13618	689	4.4	ambient dried
Tablet #5 with Cocoa Polyphenol 011797B	7602	215	6.2	ambient dried
Tablet #5 Cocoa Polyphenol 011797B	8186	209	4.5	dried at 120° F. for 60 hours

EXAMPLE 28

Granola Bar

A granola bar was made according to the following formulation:

BINDER	%
63 D.E. Corn Syrup	64.11
Partially Hydrogenated Soybean Oil (6034)	7.9
Cocoa Polyphenol Cocoa Powder	10
Calcium Carbonate	7.4
Glycerin	7
Brown Sugar (Granulated)	1
Flour Salt	1.5
Soy Lecithin	0.3
Propylgallate Solution	0.04
Vanilla Extract	0.75
	100%

For making the binder, the hydrogenated soybean oil and chocolate liquor were melted in a microwave oven at 55–64° C. The soy lecithin was dispersed into the melted oil, and the mixture was poured into a Cuisinart Mixer. The corn syrup and glycerin were preheated in a microwave to 70° C. to reduce the viscosity and added to the Cuisinart mixture along with oil, lecithin, and liquor. The ingredients were mixed in the Cuisinart for approximately 30 seconds. The dry blended ingredients were slowly added to the Cuisinart and mixed for approximately 1–2 minutes or until well blended.

A fudge formulation using cocoa polyphenol cocoa powder was made according to the following recipe:

FUDGE TOPPING	%
Powdered Sugar (6X)	27.4
High Fructose Corn Syrup (55%)	20.0
Partially Hydrogenated Soybean Oil (6034)	10.75
Lactose (Alpha Mono)	9.25
Powdered Lactose (Alpha Mono)	11.0
Cocoa Polyphenol Cocoa Powder	10.0
Glycerin	2.0
Non-Fat Dry Milk (Low-Heat)	5.0
Water	2.0

-continued

FUDGE TOPPING	%
Calcium Carbonate	1.35
Soy Lecithin	0.5
Salt	0.25
Vanilla	0.5
	100%

For making the fudge topping, the dry ingredients according to the above recipe were blended in a Kitchen Aid mixer on low speed for approximately 3–4 minutes or until well blended. The hydrogenated soybean oil was melted in a microwave oven at 55–64° C. The soy lecithin was dispersed in the melted oil. The oil/lecithin mixture was poured into the blended dry ingredients in a Hobart Mixer running on slow speed. The speed of the mixture was gradually increased and the water, glycerin, and high fructose corn syrup was added into the mix. The resulting fudge topping was mixed for 2–3 minutes or until thoroughly blended.

The finished bars were made according to the following formulations:

Granola Recipe:

Crisp Rice	30.2
Mini Wheat Flakes	33.7
Brown Sugar Oats	36.1
	100%

Finished Product Profile:

	%
Chocolate (5% Cocoa Polyphenol Cocoa Powder)	37
Granola/Rice	21
Binder	21
Fudge	21
	100%

The finished product was made according to the following:

The granola was blended with the binder and slabbed onto wax paper with a rolling pin to about 15 mm high. The fudge topping was slabbed onto the granola base and allowed to set for about an hour. The bars were cut to the following dimensions:

Height	15 mm
Width	25 mm
Length	84 mm

Cut bars were then enrobed in Cocoa Polyphenol chocolate.

Results:

Pentamer: 104 μg/g

Total Polyohenolics: 2215 μg/g

EXAMPLE 29

Cocoa Polyphenol Milk Chocolate with Cinnamon Caramel

Cocoa polyphenol milk chocolate was hand tempered at 86° F.–88° F. The tempered chocolate was then used to make

shells in various shaped molds. 965 grams of standard Caramel was warmed to 55° C. 20 grams of cocoa polyphenol cocoa powder and 15 grams of cinnamon were added to the warmed caramel and mixed well. The caramel was allowed to cool and was then pastry bagged into chocolate shells. The shells were then bottomed with tempered chocolate and removed from the molds. The molded piece consisted of 6 grams of cocoa polyphenol milk chocolate and 4 grams of caramel containing 2.0% cocoa polyphenol cocoa powder.

Finished Product:

Ingredient	Usage Level %
Cocoa Polyphenol Milk Chocolate	60
Cocoa Polyphenol Caramel	40
	100%

Results:
Pentamer: 79.8 μg/g

EXAMPLE 30

Cocoa Polyphenol Milk Chocolate with Chocolate-Flavored Nougat

Cocoa polyphenol milk chocolate was hand tempered at 86° F.–88° F. The tempered chocolate was then used to make shells in various shaped molds. The formula for chocolate-flavored nougat was used to make frappe. 5 grams of cocoa polyphenol cocoa powder was added to 104 grams of slurry which was folded into the frappe at a ratio of 92.40% frappe to 7.60% slurry. The finished chocolate-flavored nougat was then slabbed onto the cooling table and cut to fit the molded shells. The shells were then bottomed with tempered cocoa polyphenol chocolate and removed from the molds. The molded piece consisted of 22.5 grams of cocoa polyphenol milk chocolate and 12.5 grams of chocolate-flavored nougat.

Cocoa Polyphenol Nougat Ingredient	Piece Wt. = 35 g Usage Level	Choc/Center = 22.5 g/12.5 g
Chocolate-Flavored Nougat	35.71%	17
Cocoa Polyphenol Milk Chocolate	64.29%	

Results:
Pentamer: 80.3 μg/g

EXAMPLE 31

Cocoa Polyphenol Dark Chocolate with Chocolate-Flavored Nougat

Cocoa polyphenol milk chocolate was hand tempered at 86° F.–88° F. The tempered chocolate was then used to make shells in various shaped molds. The formula for chocolate-flavored nougat was used to make frappe. 5 grams of cocoa polyphenol cocoa powder and 75 grams of cocoa polyphenol dark chocolate was added to 104 grams slurry which was folded into the frappe at a racial of 92.40% frappe to 7.60% slurry. The finished chocolate-flavored nougat was then slabbed onto the cooling table and cut to fit the molded shells. The shells were then bottomed with tempered cocoa polyphenol chocolate and removed from the molds. The molded piece consisted of 22.5 grams of cocoa polyphenol dark chocolate and 12.5 grams of chocolate-flavored nougat.

Cocoa Polyphenol Chocolate-Flavored Nougat

Ingredient	Usage Level	# of Samples
Chocolate-Flavored Nougat	84.89%	20
Cocoa Polyphenol Dark Chocolate	15.0%	
Cocoa Polyphenol Cocoa Powder	0.11%	

Results:
Pentamer: 43.2 μg/g

What is claimed is:

1. An improved method for preparing chocolate liquor and partially defatted cocoa solids from the roasted cocoa beans or roasted cocoa nibs, the improvement comprising the selection of cocoa beans or blends thereof having a fermentation factor of 275 or less.

2. The method of claim **1**, which comprises the steps of:

(a) roasting the selected cocoa beans or blends thereof to an internal bean temperature of about 95° C. to about 160° C.;

(b) winnowing the cocoa nibs from the roasted cocoa beans; and

(c) milling the cocoa nibs into the chocolate liquor.

3. The method of claim **1**, which comprises the steps of:

(a) heating the selected cocoa beans at a temperature to about 95° to about 135° C. to loosen the cocoa shell from the cocoa nibs;

(b) winnowing the cocoa nibs from the cocoa shells;

(c) roasting the cocoa nibs to an internal nib temperature of about 95° C. to about 160° C.; and

(d) milling the roasted nibs into the chocolate liquor.

4. The method of claim **1**, which comprises the steps of:

(a) roasting the selected cocoa beans or blends thereof to an internal bean temperature of about 95° C. to about 160° C.;

(b) winnowing the roasted cocoa nibs from the roasted cocoa beans;

(c) milling the roasted cocoa nibs into the chocolate liquor; and

(d) recovering cocoa butter and the partially defatted cocoa solids from the cocoa liquor.

5. The method of claim **1**, which comprises the steps of:

(a) heating the selected cocoa beans or blends thereof to a temperature just sufficient to loosen the cocoa shell from the cocoa nibs;

(b) winnowing the cocoa nibs from the cocoa shells;

(c) roasting the cocoa nibs to an internal nib temperature of about 95° C. to about 150° C.;

(d) milling the roasted nibs into the chocolate liquor; and

(e) recovering cocoa butter and the partially defatted cocoa solids from the cocoa liquor.

6. The method of claims **2**, **3**, **4**, or **5**, wherein the roasting temperature is about 95° C. to about 120° C.

7. The method of claim **6** wherein the roasting time is 1 minute to 1 hour.

8. Roasted cocoa nibs, or fractions thereof, prepared from cocoa beans having a fermentation factor of 275 or less.

9. Chocolate liquor prepared from roasted cocoa beans having a fermentation factor of 275 or less.

10. Chocolate liquor containing at least about 50,000 μg of total cocoa procyanidins per gram of nonfat cocoa solids.

11. Chocolate liquor containing at least about 5,000 μg of cocoa procyanidin pentamer per gram of nonfat cocoa solids.

12. A food containing the chocolate liquor of claims **9**, **10**, or **11**.

13. The food product of claim **12** wherein the food product is a pet food, a dry cocoa mix, a pudding, a syrup, a cookie, a savory sauce, a rice mix, a rice cake, or chocolate confectionary.

14. Partially defatted cocoa solids prepared from roasted cocoa beans or blends thereof having a fermentation factor of 275 or less.

15. Partially defatted cocoa solids containing at least about 50,000 μg of cocoa procyanidin pentamer per gram of nonfat cocoa solids.

16. Partially defatted cocoa solids containing at least about 5,000 μg of cocoa procyanidin pentamer per gram of nonfat cocoa solids.

17. A food containing the partially defatted cocoa solids of claim **14**, **15**, or **16**.

18. The food product of claim **17**, wherein the food product is a pet food, a dry cocoa mix, a pudding, a syrup, a cookie, a savory sauce, a rice mix, a rice cake, or chocolate confectionary.

19. An extract containing cocoa polyphenols including cocoa procyanidins, which is prepared by solvent extracting partially defatted cocoa solids prepared from cocoa beans or cocoa nibs having a fermentation factor of 275 or less which have been roasted to an internal bean or nib temperature of about 95° C. to about 160° C.

20. A food containing the extract of claim **11**.

21. The food product of claim **20**, wherein the food product is a pet food, a dry cocoa mix, a pudding, a syrup, a cookie, a savory sauce, a rice mix, a rice cake, or chocolate confectionary.

22. A food product containing at least about 15,100 μg of total cocoa procyanidins per gram of nonfat cocoa solids, when the nonfat cocoa solids content of the food product is less than or equal to 7% by weight based on the total weight of the food product.

23. A food product containing at least about 700 μg of cocoa procyanidin pemtamer per gram of cocoa solids, when the nonfat cocoa solids content of the food product is less than or equal to 7% by weight based on the total weight of the food product.

24. The food product of claim **22** wherein the food product is a milk chocolate.

25. A food product containing at least 17,000 μg of total cocoa procyanidins per gram of nonfat cocoa solids, when the nonfat cocoa solids content of the food product is less than or equal to about 13% based on the total weight of the food product.

26. A food product containing at least 1400 μg of cocoa procyanidin pentamer per gram of nonfat cocoa solids, when the nonfat cocoa solids content of the food product is less than or equal to about 16% based on the total weight of the food product.

27. A food product containing at least about 22,065 μg of total cocoa procyanidins per gram of cocoa nonfat solids, when the nonfat cocoa solids content of the food product is at least about 35% nonfat cocoa solids based on the total weight of the food product.

28. A food product containing at least about 20,500 μg of total cocoa procyanidins per gram of nonfat cocoa solids, when the nonfat cocoa solids content of the food product is at least about 37% nonfat cocoa solids based on the total weight of the food product.

29. A food product containing at least about 1,860 μg of cocoa procyanidin pentamer per gram of nonfat cocoa solids, when the nonfat cocoa solids content of the food product is at least about 37% nonfat cocoa solids based on the total weight of the food product.

30. The food product of claim **22**, wherein the food product is a dark chocolate.

31. A food product containing at least about 15,000 μg of total cocoa procyanidins per gram of nonfat cocoa solids, when the nonfat cocoa solids content of the food product is less than about 30% based on the total weight of the food product.

32. A cocoa powder dry mix containing about 4325 μg of total cocoa procyanidins per gram of nonfat cocoa solids, when the nonfat cocoa solids content of the dry mix is about 16% based on the total weight of the dry mix.

33. A method of improving the health of a mammal, which method comprises administering to the mammal a composition containing at least one cocoa polyphenol ingredient, which ingredient is selected from the group consisting of chocolate liquor, partially defatted cocoa solids, synthetic procyanidin monomers and oligomers, derivatives of the synthetic procyanidin monomers and oligomers, which ingredients are prepared from underfermented cocoa beans having a fermentation factor of 275 or less.

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